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Early Pliocene Benthic Foraminifers from the Salina Basin, southeastern Mexico

by

Barry Kohl

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EARLY PLIOCENE BENTHIC FORAMINIFERS FROM THE SALINA BASIN, SOUTHEASTERN MEXICO

By

BARRY KOHL

Chevron U.S.A.
935 Gravier Street
New Orleans, LA 70112

ABSTRACT

This study comprises the taxonomic, biostratigraphic, and paleoecologic analyses of early Pliocene foraminifers in the western Salina Basin of southeastern Mexico. Three "biozones", the Encanto, the upper Concepcion, and the lower Concepcion (all previously designated as formations), lying within a 600 sq km area centered around Acayucan, Veracruz, are the focus of this study. Ranges of key planktic foraminifers and calcareous nannoplankton indicate that these "biozones" belong to Neogene Zones 19 and 20 of Blow (1969).

Collections of benthic foraminifers from the Encanto and Concepcion "biozones" contain 212 taxa assigned to 108 genera. The following species are new: *Chrysalogonium spinastelliferum, Discorbis*? *olutensis, Ehrenbergina olmeca,* and *Oolina sayulensis.* Ninety-one percent of the species described in this study occur in Pliocene sediments in the subsurface continental shelf of Louisiana and Texas. Many Pacific taxa are recorded for the first time from the Gulf of Mexico coastal plain.

Three assemblage zones, based on key benthic foraminifers, are proposed. The *Melonis affinis–Uvigerina hispida* Assemblage Zone, having a middle to upper bathyal paleobathymetry, is equivalent to the Encanto "biozone". This biozone is overlain by the *Marginulinopsis hispaniolana–Anomalinoides nucleatus* Assemblage Zone, which is equivalent to the lower Concepcion (upper bathyal to outer neritic). The youngest unit, the *Bolivina imporcata–Saracenaria nuttalli* Assemblage Zone (outer neritic to middle neritic), is equivalent to the upper Concepcion.

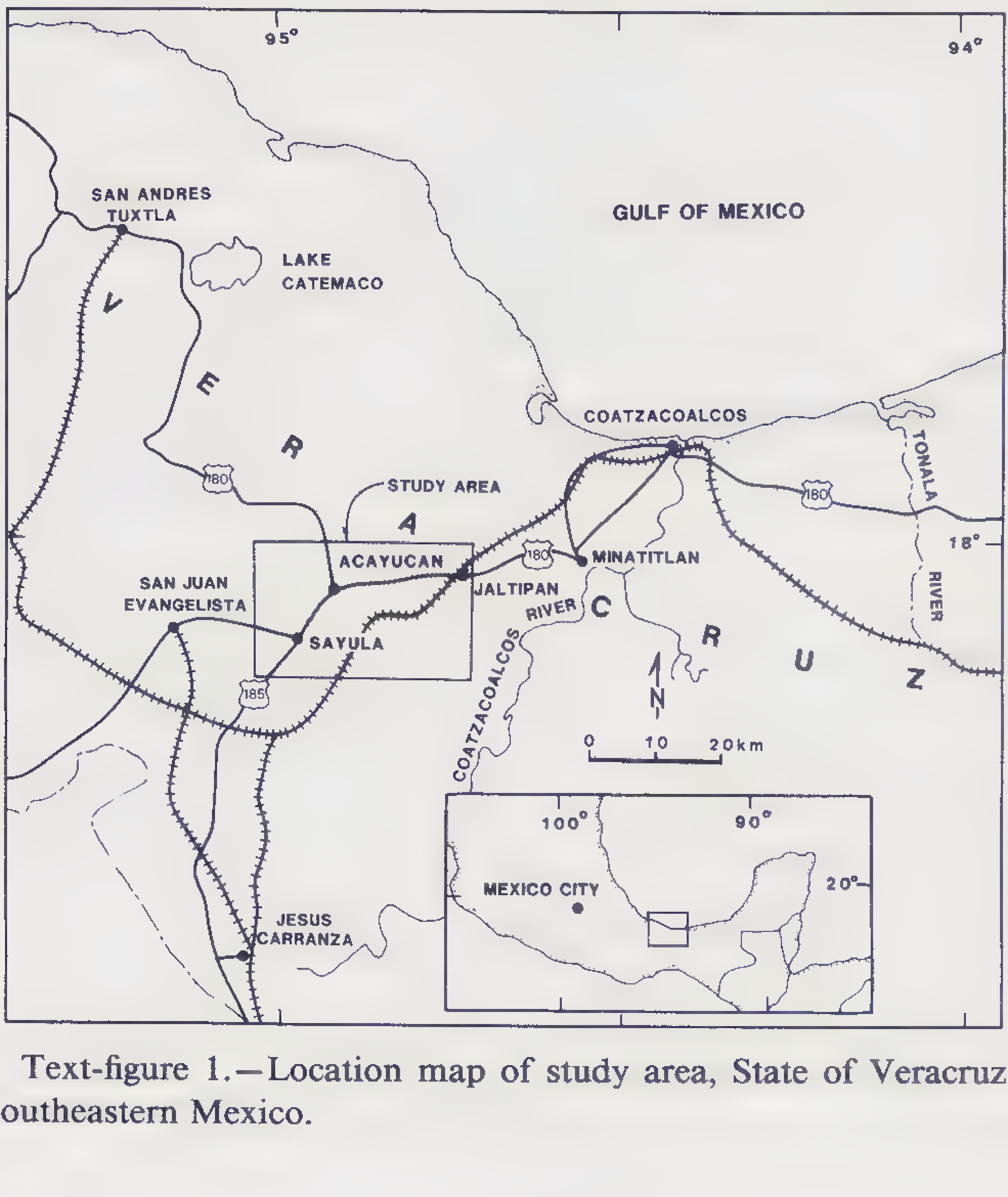
The gradual decrease in paleo water depth from upper bathyal to middle neritic, as indicated by changes in the foraminiferal assemblages, supports the probability of a Salina Basin uplift coincident with the uplift and early Pliocene closure of the Isthmus of Panama at 3.5 my.

INTRODUCTION

The primary objectives of this study are: first and principally, to record and illustrate, with scanning electron photomicrography, the early Pliocene benthic foraminifers of the study area; second, to define the precise geological age of strata sampled by using key planktic foraminifers and calcareous nannoplankton; and, third, to determine the paleoenvironments of the relevant Pliocene strata.

Concepcion and Encanto strata that crop out in a 600 sq km area centered around Acayucan, Veracruz (see Text-fig. 1) are the focus of this investigation. This area was selected because of its extensive exposures of early Pliocene strata. A field trip to the subject location was undertaken in March of 1975.

During the course of the study it became apparent that the strata traditionally subdivided into the upper and lower Concepcion formations and the Encanto Formation by Mexican geologists could not be distinguished on the basis of lithology. Indeed, these strata are not lithostratigraphic, but rather biostratigraphic units. The North American Stratigraphic Code (NACSN, 1983; art. 54, p. 863) recommends that biostratigraphic units bear a name "which is compound and designates the kind of biozone". Because the Encanto and Concepcion do not qualify as such, the biostratigraphic units qualified by these modifiers are not biozones. This informal usage of these formational names is herein recognized by the insertion of quotation marks around the noun *biozone* (*e.g.,* Encanto



Text-figure 1.—Location map of study area, State of Veracruz, southeastern Mexico.

"biozone"). Their equivalence to properly-designated biostratigraphic units is discussed under *Biozones.*

Exploratory oil and gas wells drilled on the continental shelf of Texas and Louisiana have penetrated thick sequences of outer neritic and bathyal Pliocene sediments. Age correlation and paleoecologic analysis of these sediments are of great economic importance to the petroleum industry. Although many paleontologists are investigating subsurface relationships, there have been few publications on the benthic foraminifers of these strata.

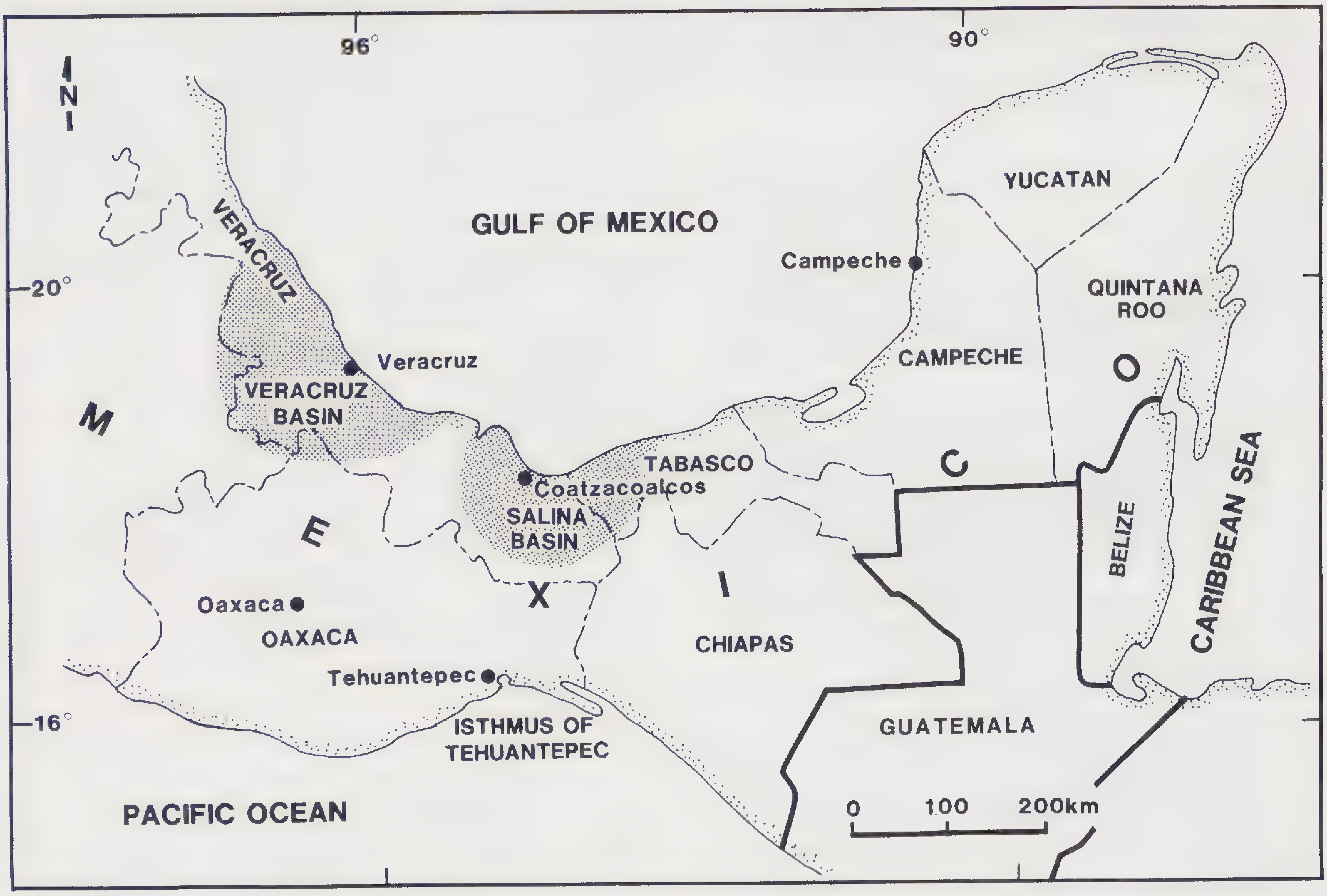
Cuttings samples from exploratory wells are seldom suitable for comprehensive biostratigraphic research because of downhole contamination, poor preservation, and the difficulty of subsequent re-sampling. Outcrop samples of Pliocene age that are suitable for taxonomic investigations and represent outer neritic and upper bathyal sediments do not occur along the Gulf coastal plain of Texas and Louisiana. A few outcrops of marine Pliocene rocks appear in Florida, but these represent shallow neritic facies.

In the Gulf coastal plain of Mexico, however, exposures of deep marine strata of Pliocene age do occur in two areas: the Veracruz and Salina basins, with outcrops more numerous in the latter (see Text-fig. 2). Rapid burial, a lack of significant structural deformation, and the presence of thick shale sequences with no appreciable alteration have contributed to the excellent preservation of microfaunas within the Salina Basin. This excellent preservation and a high species diversity of foraminifers (206 species and six subspecies from 108 genera) make the Salina Basin ideal for a detailed taxonomic study of Pliocene benthic assemblages. Similar assemblages occur in wells drilled on the outer continental shelves of Texas and Louisiana. Thus, the taxonomic and paleoecological data presented herein should prove useful for future studies in other parts of the Gulf of Mexico region.

PREVIOUS WORK

Some of the first paleontologic investigations in the Salina Basin were conducted by Spencer (1897), Toula (1910), and Böse (1910), who collected molluscs from Pliocene and Miocene outcrops along the Tehuantepec railroad. A summary discussion of the findings of these workers and others can be found in Schuchert (1935, p. 373).

Oil exploration stimulated the study of benthic for-



Text-figure 2.—Map of southeastern Mexico showing the two major Tertiary basins.

aminifers in the Salina Basin. Several unpublished reports by W. L. Nuttall, T. F. Grimsdale, and R. W. Barker from 1928 to 1935 were completed for Petroleos Mexicanos (PEMEX) [*fide* Sansores and Flores-Covarrubias, 1972b]. These reports dealt with the benthic foraminifers of the central and eastern Isthmus and parts of Tabasco.

Thalmann (1935) published the first report on the occurrence of foraminifers from the strata of the Salina Basin. He listed diagnostic benthic species for each "formation" recognized. Gibson (1936) continued Thalmann's investigation and further subdivided the strata using benthic foraminifers (see Text-fig. 7).

Sansores and Flores-Covarrubias (1972b) completed an operational manual of benthic foraminifers for PEMEX. This manual is a compilation of diagnostic benthic foraminifers from the Miocene and Pliocene strata and is based on subsurface data from oil and gas wells drilled in the Salina Basin.

Akers (1972, 1979, 1980) and Akers and Koeppel (1973) have determined the age of various formations from outcrops in the Salina Basin and elsewhere in the Isthmus of Tehuantepec by using planktic foraminifers and calcareous nannoplankton. To date, no detailed investigation of early Pliocene benthic foraminifers of the Isthmus of Tehuantepec has been published.

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The writer is indebted to Dr. Eduardo Guzman, who, as director of the PEMEX Research Laboratory, sent pertinent literature and topographic maps, which greatly aided field work in the Isthmus of Tehuantepec. Mr. R. W. Barker of Shell Research Corp. (retired), loaned faunal slides from wells penetrating Pliocene strata in the Isthmus and discussed the stratigraphic relationships of those strata with the writer. Mr. Duane O. LeRoy of Exxon Corp. loaned holotype and topotype material collected by L. W. LeRoy from the Tertiary of Okinawa and the Dutch East Indies. This material helped in the identification of Mexican species common to the western Pacific. Dr. Isabelle Premoli-Silva of the Institute of Paleontology, Milan, Italy, supplied outcrop material from Pliocene localities of northern Italy and Sicily. Dr. A. N. Eva of the University of the West Indies gave the writer outcrop material from the classic Pliocene and Miocene localities of Jamaica. Dr. M. S. Srinivasan provided samples from Schwager's localities in Car Nicobar.

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The writer would like to express special thanks to his wife, Gail Peterson Kohl, who assisted in all the field work in Mexico and helped in the preparation of the manuscript.

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REGIONAL GEOLOGY

The Salina Basin of the Isthmus of Tehuantepec, southeastern Mexico, includes parts of the states of Veracruz, Oaxaca, Tabasco and Chiapas. Physiographic features of the Isthmus are shown in Text-figure 3. There were two major sources of sediments for the Salina Basin: the southern Sierra Madre, a mountainous region trending northwest to southeast along the southern portion of the Isthmus, contributing siliciclastic material; and the Sierra San Andres Tuxtla, a localized area of volcanism near the Gulf of Mexico on the northwest side of the Basin, contributing pyroclastic material.

Five tectonic regions are recognized in the Isthmus of Tehuantepec: 1) Sierra San Andres Tuxtla massif; 2) Southern Sierra Madre massif; 3) Metamorphic zone of the Isthmus; 4) Sierra Madre Anticlinorium; and 5) Salina Basin (Text-fig. 4).

The San Andres Tuxtla massif is composed of several dormant volcanoes, the highest being San Martin, located 45 km north of Acayucan, Veracruz. San Martin has an elevation of 1800 m and last erupted in 1793. The massif is a diorite laccolith with volcanic extrusives of andesite and basalt. Volcanism surrounding the Tuxtla volcanoes was most extensive during the Miocene, decreasing through the Pliocene to Holocene (Macbeth, 1956, pp. 35–37).

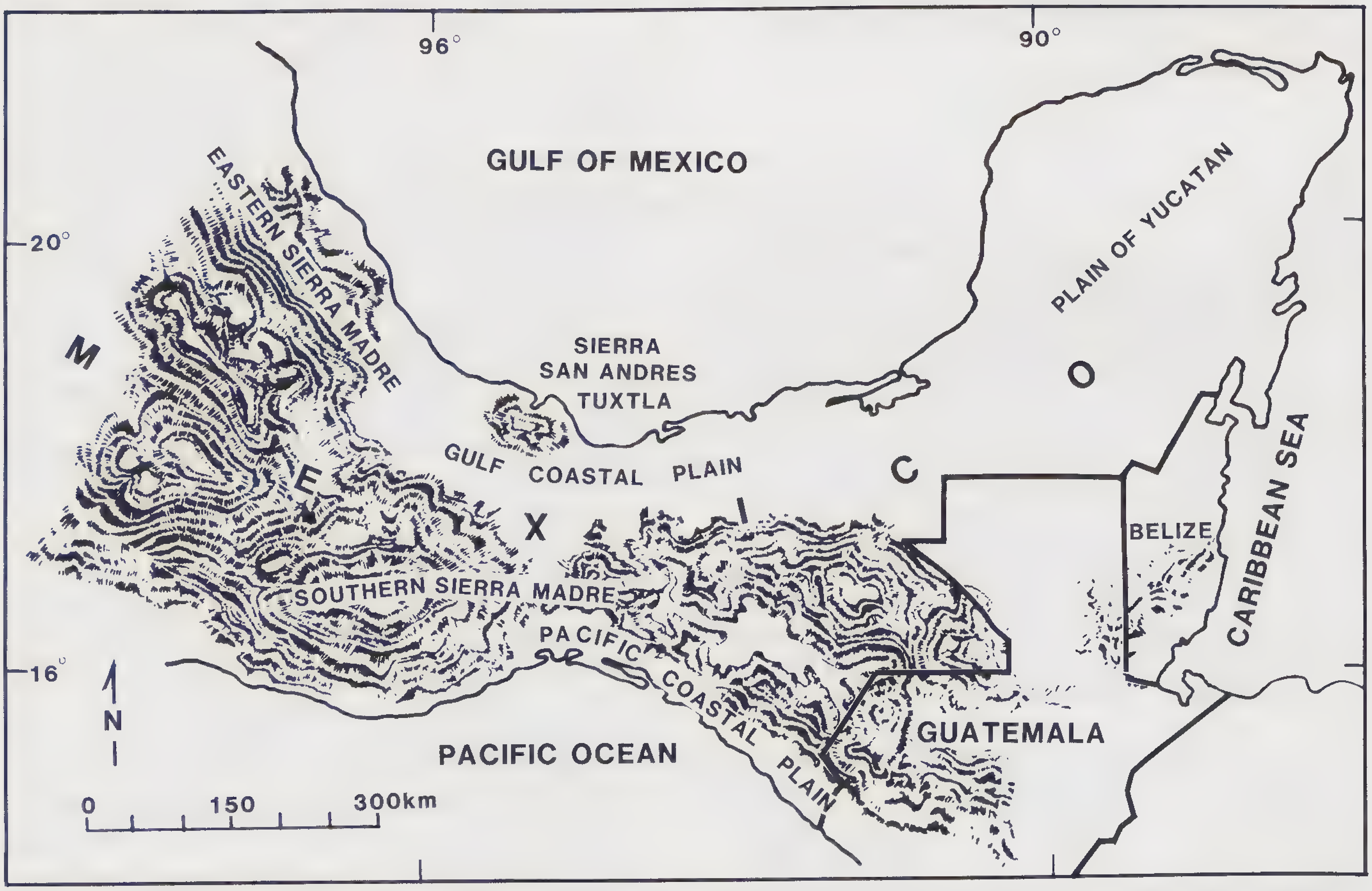
The massif of the southern Sierra Madre is a large granite batholith of pre-Carboniferous age extending parallel to the Pacific Coast through the states of Chiapas and Oaxaca. It is 300 km in length and 80 km wide with elevations of up to 2900 m (Contreras, 1956, p. 103). A metamorphic zone in the massif (Text-fig. 4) occurs within the southernmost portion of the Isthmus of Tehuantepec and consists of sericite schist and quartzite considered to be Permian in age.

The Sierra Madre Anticlinorium (Text-fig. 4), on the northern side of the southern Sierra Madre massif, is recognizable by its thrust faults and recumbent anticlines of Cretaceous limestone and Eocene clastics. Eocene strata make up 95 percent of the outcrops in the Anticlinorium (Contreras, 1956, p. 49).

Another tectonic area, the Salina Basin, is the site of the present investigation. It is generally bounded by the Gulf of Mexico on the north, the Sierra Madre Anticlinorium on the south, the Sierra San Andres Tuxtla on the west, and the Tonalá River on the east (Text-fig. 4).

According to Contreras and Castillón (1968, p. 244), the Salina Basin derives its name from salt encountered during petroleum exploration around the turn of the century. In 1902, the first wells were drilled on the Potrerillos Dome (also called Jaltipan Dome on early geologic maps) in the western part of the Basin. Because of continued active drilling, many studies into the origin of this salt have been undertaken. Salas (1967, p. 16) stated that unpublished palynological studies place the age of the salt as Liassic (Early Jurassic) and probably correlative to the Louann Salt Formation of northeastern Mexico, Texas and Louisiana. Contreras and Castillón (1968) dated the salt as pre-Kimmeridgian or pre-Chinameca Limestone in age, based on its relationship to the only outcrop of marine Jurassic strata in the area. The Chinameca Limestone overlies the salt at the Chinameca Dome northeast of Jaltipan, Veracruz (see Text-fig. 6). According to Kirkland and Gerhard (1971), all circum-Gulf of Mexico evaporite sequences are related and are probably of the same age (Middle to Late Jurassic).

Humphris (1979), in a generalized map (Text-fig. 5), depicted the areas of diapiric salt in the Gulf of Mexico. One, the Gulf basin, contains diapirs of the Texas–Louisiana shelf and slope and the Sigsbee Knolls–Campeche Knolls–Salina Basin trend. Diapiric salt structures formed in the Salina Basin in response to the loading of late Cretaceous, Paleocene, and Eocene sediments (Contreras and Castillón, 1968). The sediment



Text-figure 3.—Physiographic features in southeastern Mexico. The southern Sierra Madre is the major source of siliciclastics deposited in the Salina Basin to the north (after Contreras, 1956).

source was the Sierra Madre land mass to the south, uplifted during the Laramide Orogeny (Fuente-Navarro, 1959, p. 40) contributing sediments throughout the Tertiary with an accumulated thickness of more than 10 km near the center of the basin (Contreras and Castillón, 1968).

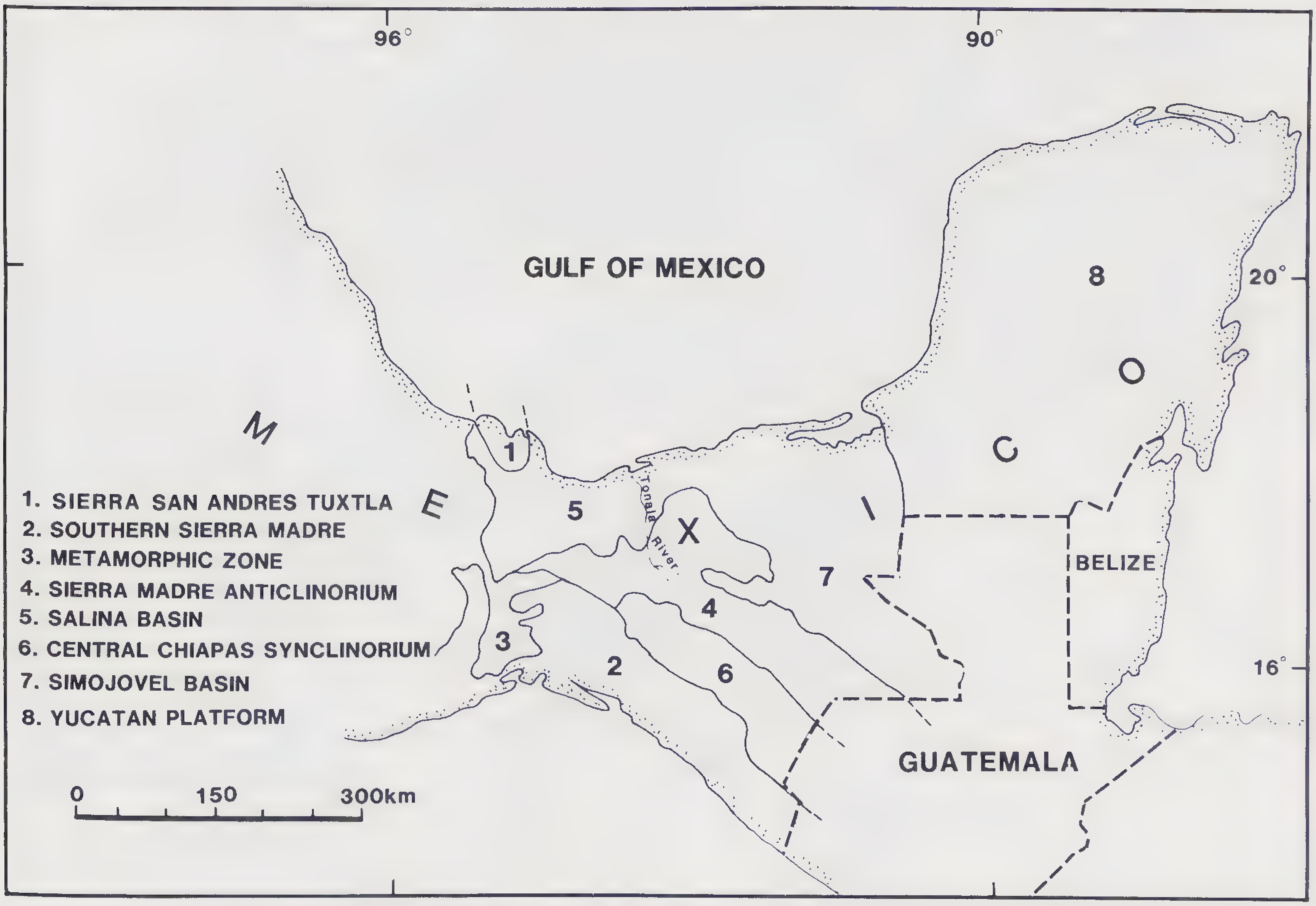
During the Miocene the Salina Basin subsided to reach water depths of over 3000 m, based on studies of benthic foraminifers (Sansores and Flores-Covarrubias, 1972). Thick bathyal shales are interbedded with volcanic ash more than 4 m thick, which came from the Tuxtla volcanoes in the northwestern portion of the basin (Contreras and Castillón, 1968).

Many authors (Spencer, 1897; Vaughan, 1917; Woodring, 1931; Schuchert, 1935, and others) believed that there had been a Cenozoic interoceanic connection between the Gulf of Mexico and the Pacific Ocean at the Isthmus of Tehuantepec. This idea was based primarily on the occurrence of fossil mollusc and coral species which were common to the Gulf of Mexico and eastern Pacific faunal provinces.

Durham, Arellano, and Peck (1955), unable to find any Cenozoic marine sediments on either side of the crest of the Continental Divide, concluded that there were no seaways crossing the Isthmus during that period. The southern Sierra Madre was evidently in existence throughout the Cenozoic, as indicated by the thinning sequences of Tertiary marine sediments on the Gulf-side flanks of these mountains.

The interconnection through the Isthmus of Panama has been well documented. According to Berggren and Hollister (1974), the Isthmus of Panama was elevated above sea level approximately 3.5 million years ago. This uplift may have extended as far north as Mexico, affecting the Isthmus of Tehuantepec by elevating the southern Sierra Madre and the Salina Basin.

The shallowing of the Basin is evident from paleoenvironmental studies based on benthic foraminiferal faunas of successively younger strata (Sansores and Flores-Covarrubias, 1972b). Miocene sediments that were deposited in water depths greater than 1500 m (lower bathyal) are exposed in roadcuts 150 m above present sea level in the study area. This would suggest that there has been at least 1600 m of change, mainly as uplift, since the deposition of these Miocene sediments. Since some of the uplift is associated with salt



Text-figure 4.—Tectonic subdivision of southeastern Mexico. The Salina Basin (5) is the focus of the present investigation (modified from Contreras, 1956).

diapirism, with many elevated areas in the Salina Basin resulting directly from salt diapirs and salt ridges, the regional uplift of the Basin may have been somewhat less than 1600 m.

Outcrop patterns in the western portion of the Salina Basin are controlled almost exclusively by salt domes and salt ridges, the salt sometimes occurring within 50 m of the surface. These high areas are dissected by erosion, exposing Pliocene and older sediments, which are surrounded by Quaternary alluvium (see Text-fig. 6).

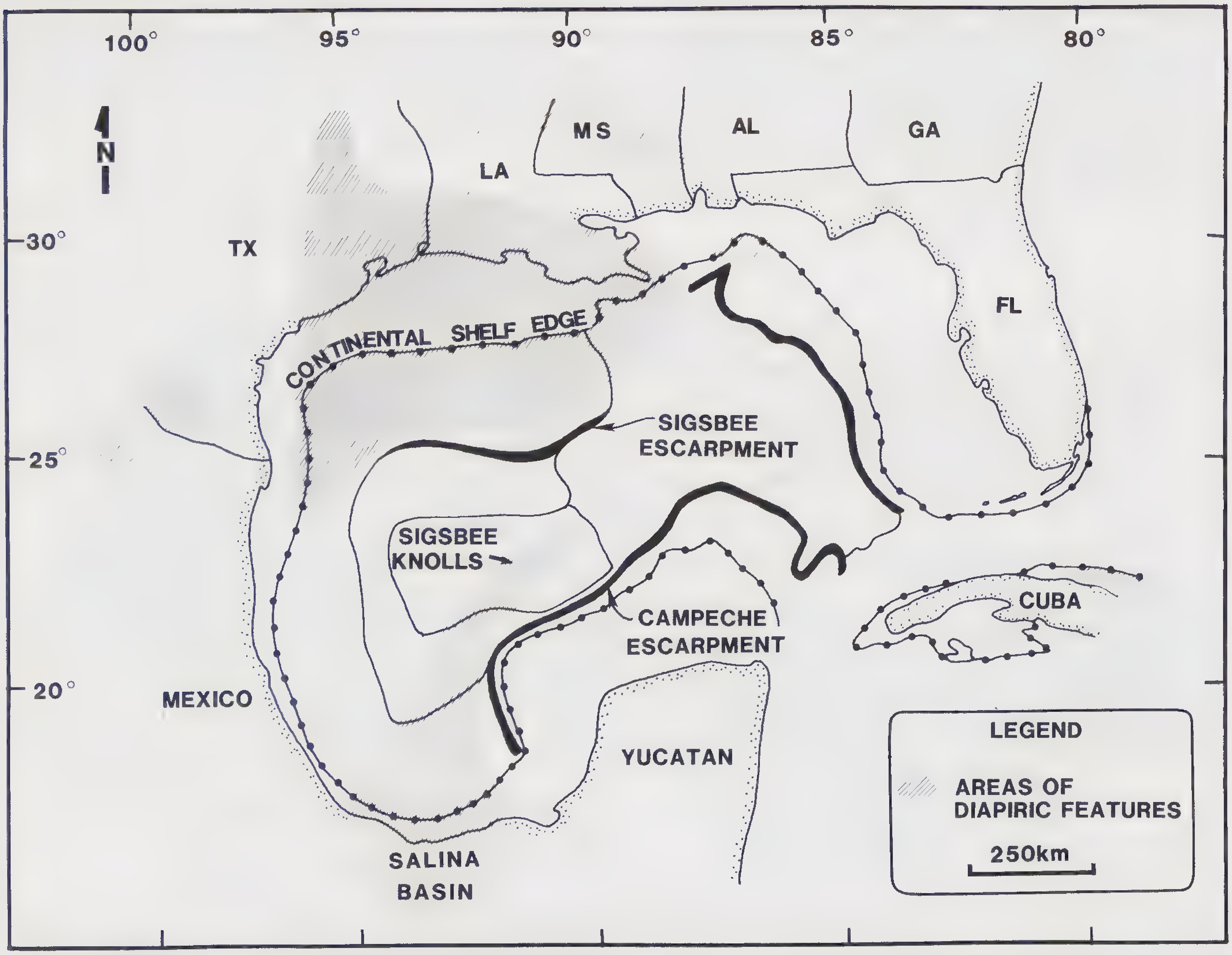
TECHNIQUES AND METHODS

The study took place in a 600 sq km area west of the Coatzacoalcos River in the western part of the Salina Basin (see Text-figs. 1, 6). Two collecting traverses were made: one along Highway 180 between Acayucan and Jaltipan for a distance of 20 km (A–A′); and a second along Highway 185 south from Acayucan for a distance of 15 km (B–B′).

These two traverses were chosen because the construction of Highways 180 and 185 created many exposures of Pliocene and Miocene strata in roadcuts. The traverse from Acayucan to Jaltipan crosses the Potrerillos Dome and the traverse from Acayucan south crosses the Sayula Dome. As shown in Text-figure 6, Encanto and Concepcion strata crop out along flanks of these two salt domes, though at no point is a complete stratigraphic section exposed and accessible. Since the Pliocene sections on both flanks of the two domes were exposed by the highway roadcuts, it was possible to assemble a composite stratigraphic section of the Concepcion and Encanto strata.

Seventy samples were collected from traverses A–A′ and B–B′. Twelve additional samples, not used in the body of this report, were taken in peripheral areas in order to corroborate the age dating shown on the PEMEX geologic maps. Detailed descriptions of all sample localities are provided in the Appendix.

High rainfall in the region (60–80 in/yr) led to the

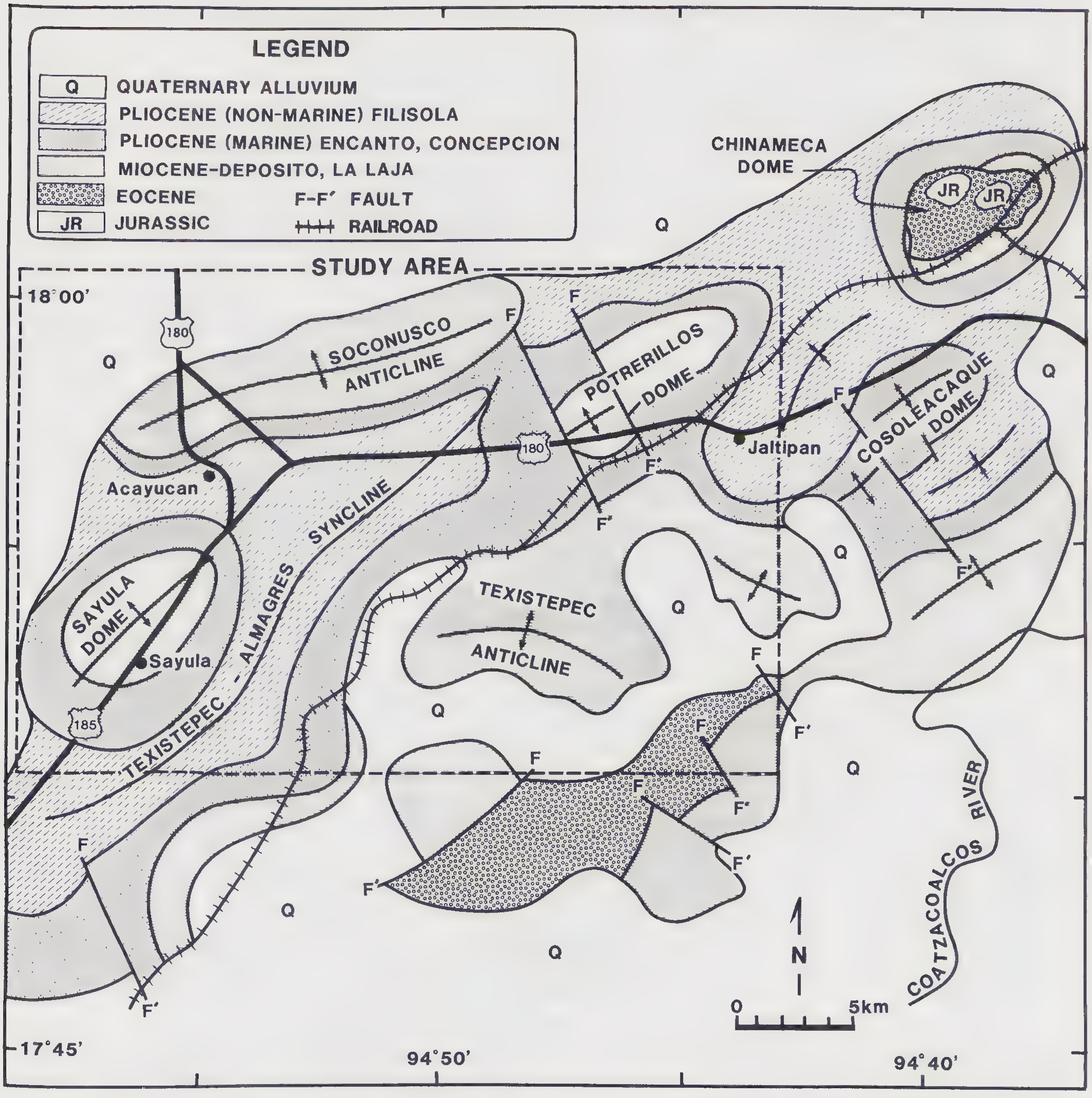


Text-figure 5.—Diapiric salt features of the Gulf of Mexico and Gulf Coastal Plain (modified from Humphris, 1979).

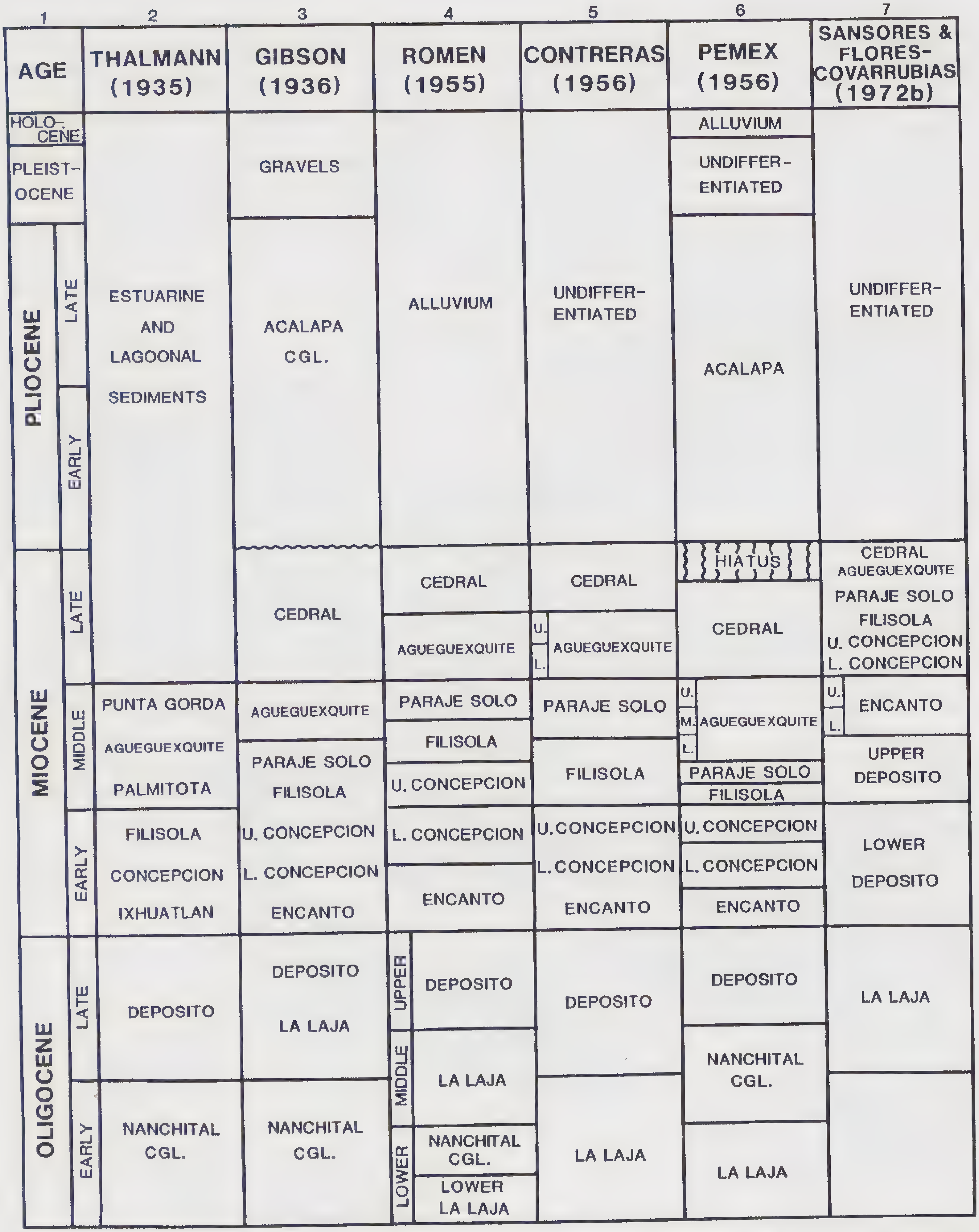
expectation of a deep weathering zone, so a hand auger was initially used as a collecting tool. Fortunately, the first samples collected by this method revealed that the weathered zone was only a few cm thick. Because the lithology was dominantly an impermeable silty clay, there was no apparent leaching of the foraminiferal tests and it was possible to continue sampling with a small shovel and trowel. A thin soil layer of about 3 cm was removed and approximately 1 kg of material taken at each station. Eighty-two samples were collected from 38 localities.

SAMPLE PREPARATION

All samples for this study were prepared for microscopic examination by placing 80 gm of raw material in a pan containing 1.5 liters of water with 0.3 ml of trisodium phosphate. The sample was then boiled for two to three hours. In the second step, a stock solution

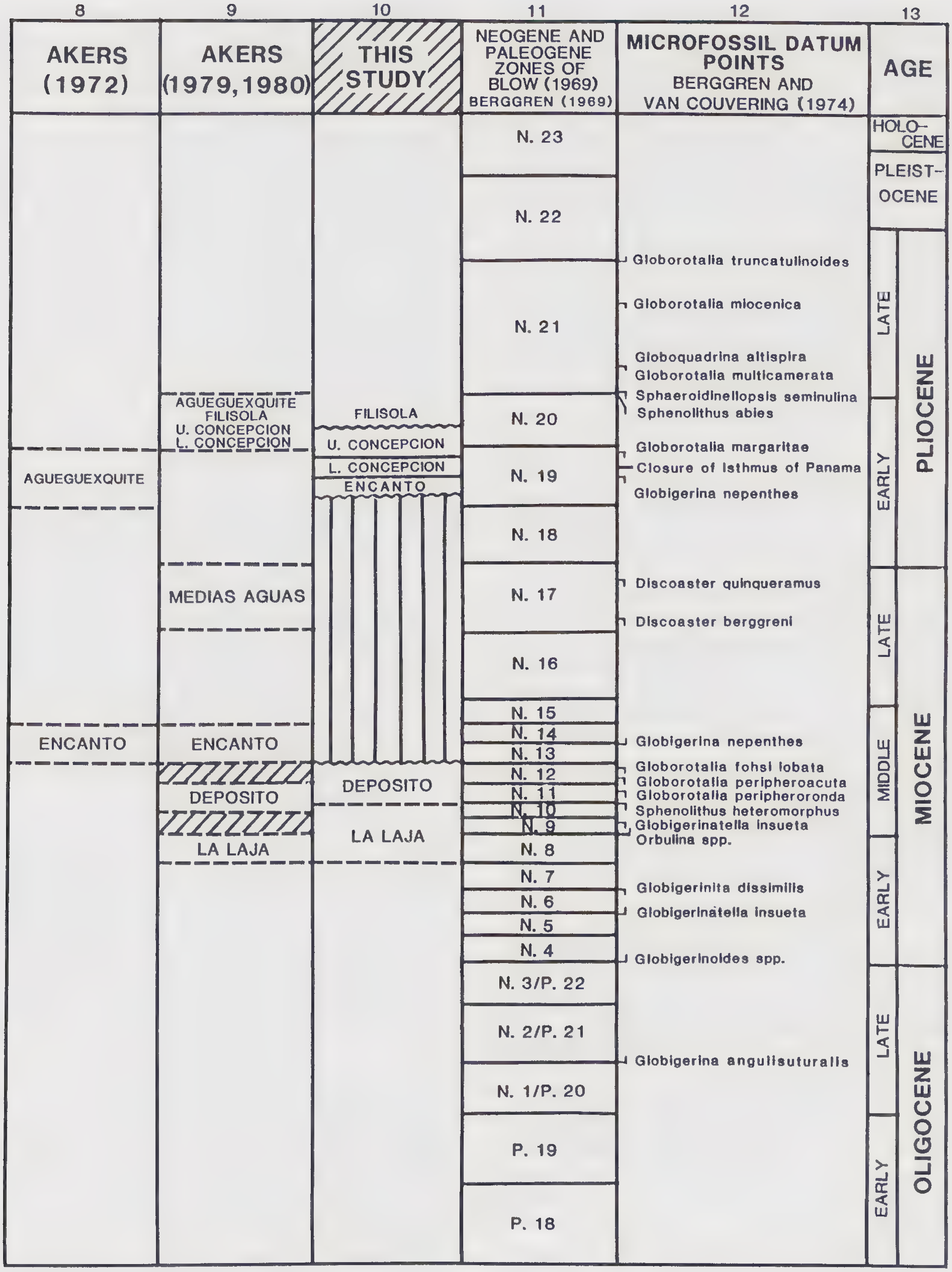


Text-figure 6.—Surficial geologic map with outline of the study area west of the Coatzacoalcos River, southern Veracruz. The Sayula and Potrerillos domes are the center of this study (after Contreras, 1956).



1		2	3	4	5	6	7
AGE		THALMANN (1935)	GIBSON (1936)	ROMEN (1955)	CONTRERAS (1956)	PEMEX (1956)	SANSORES & FLORES-COVARRUBIAS (1972b)
HOLOCENE		ESTUARINE AND LAGOONAL SEDIMENTS	GRAVELS	ALLUVIUM	UNDIFFERENTIATED	ALLUVIUM	UNDIFFERENTIATED
PLEISTOCENE						UNDIFFERENTIATED	
PLIOCENE	LATE		ACALAPA CGL.			ACALAPA	
	EARLY						
MIOCENE	LATE		CEDRAL	CEDRAL AGUEGUEXQUITE	CEDRAL U. L. AGUEGUEXQUITE	HIATUS CEDRAL	CEDRAL AGUEGUEXQUITE PARAJE SOLO FILISOLA U. CONCEPCION L. CONCEPCION
	MIDDLE	PUNTA GORDA AGUEGUEXQUITE PALMITOTA	AGUEGUEXQUITE PARAJE SOLO FILISOLA	PARAJE SOLO FILISOLA U. CONCEPCION	PARAJE SOLO FILISOLA	U. M. L. AGUEGUEXQUITE PARAJE SOLO FILISOLA	U. L. ENCANTO UPPER DEPOSITO
	EARLY	FILISOLA CONCEPCION IXHUATLAN	U. CONCEPCION L. CONCEPCION ENCANTO	L. CONCEPCION ENCANTO	U.CONCEPCION L.CONCEPCION ENCANTO	U.CONCEPCION L.CONCEPCION ENCANTO	LOWER DEPOSITO
OLIGOCENE	LATE	DEPOSITO	DEPOSITO LA LAJA	UPPER: DEPOSITO MIDDLE: LA LAJA	DEPOSITO	DEPOSITO NANCHITAL CGL.	LA LAJA
	EARLY	NANCHITAL CGL.	NANCHITAL CGL.	LOWER: NANCHITAL CGL. LOWER LA LAJA	LA LAJA	LA LAJA	

Text-figure 7.—Age assignment of strata in the Salina Basin, Isthmus of Tehuantepec (Oligocene through Holocene). Summary of age determinations for strata found in the study area are shown in columns 11 and 12. The ages are related to Neogene Zones of Blow (1969) and important paleontologic datum points. Neogene Zones N.13 through N.18 are missing in the study area (column 10).
The closure of the Isthmus of Panama is shown at 3.5 my, just above the extinction datum of *G. nepenthes* (N.19).


8
9
10
11
12
13
AKERS (1972)
AKERS (1979,1980)
THIS STUDY
NEOGENE AND PALEOGENE ZONES OF BLOW (1969) BERGGREN (1969)
MICROFOSSIL DATUM POINTS BERGGREN AND VAN COUVERING (1974)
AGE
AGUEGUEXQUITE
ENCANTO
AGUEGUEXQUITE
FILISOLA
U. CONCEPCION
L. CONCEPCION
MEDIAS AGUAS
ENCANTO
DEPOSITO
LA LAJA
FILISOLA
U. CONCEPCION
L. CONCEPCION
ENCANTO
DEPOSITO
LA LAJA
N. 23
N. 22
N. 21
N. 20
N. 19
N. 18
N. 17
N. 16
N. 15
N. 14
N. 13
N. 12
N. 11
N. 10
N. 9
N. 8
N. 7
N. 6
N. 5
N. 4
N. 3/P. 22
N. 2/P. 21
N. 1/P. 20
P. 19
P. 18
Globorotalia truncatulinoides
Globorotalia miocenica
Globoquadrina altispira
Globorotalia multicamerata
Sphaeroidinellopsis seminulina
Sphenolithus abies
Globorotalia margaritae
Closure of Isthmus of Panama
Globigerina nepenthes
Discoaster quinqueramus
Discoaster berggreni
Globigerina nepenthes
Globorotalia fohsi lobata
Globorotalia peripheroacuta
Globorotalia peripheroronda
Sphenolithus heteromorphus
Globigerinatella insueta
Orbulina spp.
Globigerinita dissimilis
Globigerinatella insueta
Globigerinoides spp.
Globigerina angulisuturalis
HOLOCENE
PLEISTOCENE
LATE
EARLY
PLIOCENE
LATE
MIDDLE
EARLY
MIOCENE
LATE
EARLY
OLIGOCENE

of 6 percent Quaternary "O" (see Zingula, 1968) was used and consisted of 240 ml of paste dissolved in 3.8 liters of water containing the sample residue from the previous boiling. Twenty-five ml of the solution were added to 1.5 liters of water. The "mixture" was boiled for one to two hours with the liquid volume maintained by the addition of water to keep the concentration of Quaternary "O" constant. The residues were examined periodically with a binocular microscope to assure that the matrix had broken down completely.

This technique assured not only the disaggregation of the matrix but also yielded extremely clean foraminifers. Close monitoring is essential when cleaning delicate, well-preserved foraminifers with Quaternary "O". If the concentration is allowed to increase too much, etching of the tests can occur. Under extreme conditions there could be complete destruction of the tests.

The cleaned residue was wet-sieved on a standard U.S. 200 mesh screen (74 μm) and the residue (particles larger than 74 μm) was dried. In many samples, the residue consisted entirely of a microfauna composed of foraminifers, ostracodes, and echinoid spines.

The dry, sieved residue was split with a microsplitter to produce an aliquot that included three hundred or more benthic foraminifers larger than 100 mesh (194 μm) (see Chang, 1967). The number of specimens of each benthic species were recorded and computed as a percentage of the total benthic foraminiferal assemblage.

Relative abundance of each planktic foraminifer species and the total number of planktic foraminifer specimens per sample were recorded to compute the planktic/benthic ratio of each sample and to provide abundance data for subsequent charts.

SEM MICROPHOTOGRAPHY

Specimens of each species were "photographed" with a Cambridge "Stereoscan" model Mark 2A scanning electron microscope [SEM]. Several well-preserved specimens of each species were selected and mounted on the tops of aluminum stubs to which double-stick tape had been affixed.

After coating with 280 Å of gold-palladium, each stub was scanned with a beam potential of 10 kV and a final aperture of 50 μm for magnifications less than 2000×. When magnifications of greater than 2000× were needed, a 200 μm final aperture and a 20 kV beam potential was used.

The film selected for all SEM work was a Polaroid (Polapan) Type 52 with a speed of ASA 400.

LIGHT PHOTOGRAPHY

Several of the species "photographed" with the SEM exhibited a very smooth surface with no diagnostic external features. Where this problem was encountered, supplemental light photographs were included to illustrate the necessary diagnostic test features, such as the number and shape of chambers.

Photos were taken with a Zeiss Photoscope model "I" with Zeiss Luminar objective lens and a Schott-Mainz lamp with two fiber optic beams, a source that projects a high-intensity light which can be positioned very close to the specimen. Since fiber optic light is relatively cool, it was possible to use water rather than oil as a wetting agent to emphasize contrast during the photography. These specimens were later coated with gold-palladium and "photographed" by SEM.

BIOSTRATIGRAPHY AND STRUCTURAL FEATURES

This study includes strata assigned by PEMEX geologists to the upper Concepcion Formation, lower Concepcion Formation, and the Encanto Formation. Text-figure 7 is a comparison of age assignments by various authors for strata in the Isthmus of Tehuantepec that range in age from Oligocene to Holocene. The Neogene planktic foraminiferal zonation scheme of Blow (1969) is adopted for the present study with further Pliocene calibration as proposed by Berggren (1973) and Berggren and Van Couvering (1974).

PLIOCENE STRATA

Filisola Formation

The term Filisola was first used by Thalmann (1935) for shallow water marls and sands interpreted as early Miocene. In the study area, samples from localities designated as the Filisola Formation by PEMEX geologists are nonmarine (barren of foraminifers). The lithology is a distinctive reddish, noncalcareous siltstone. Akers (1979) assigned the Filisola to Zone N.20 (early Pliocene) using planktic foraminifers from a marine facies (loc. TU 1141) near San Andres Tuxtla, 70 km northwest of the present study area.

Concepcion

Thalmann (1935) introduced the term Concepcion and assigned the strata to the early Miocene. Gibson (1936) subdivided the Concepcion into an upper and lower unit, both of which were generally considered to be early Miocene by most Mexican geologists, until Sansores and Flores-Covarrubias (1972b) placed the strata in the late Miocene. Akers and Koeppel (1973) dated these strata by using ranges of key calcareous nannoplankton and planktic foraminifers. They referred to the early Pliocene beds that were considered part of the Concepcion Formation by Mexican geologists. These strata, found in roadcuts east of the Coatzacoalcos River, were assigned to Neogene Zone 20 of Blow (1969) by Akers and Koeppel (1973).

Encanto

The name Encanto was introduced by Gibson (1936), replacing the term Ixhuatlan, which had been proposed by Thalmann (1935). Gibson assigned the Encanto strata to the early Miocene while Sansores and Flores-Covarrubias (1972b) placed it in the middle Miocene. Akers (1972) dated strata that he referred to the Encanto Formation, and which were located 50 km south of the study area, as equivalent to Neogene Zone 13–14 (middle Miocene). But samples from locality TU 1083, within the study area and interpreted as Encanto herein, were assigned by Akers (1979) to N.20 (early Pliocene). He based his determinations on the occurrences of key planktic foraminifers and calcareous nannoplankton.

I have examined the strata assigned to the Concepcion Formation and the Encanto Formation in the area of the present study. The lithology is a uniform silty clay with no apparent lithologic changes.

Viniegra *et al.* (1956, pp. 166–168) describe the contacts between the various formations encountered along the route of Excursion C-7, which is in part coincident with traverse A–A′, and state:

> The contact between the upper and lower Concepcion is determined through micropaleontology. The lithology is very similar in both .... The lower Concepcion–Encanto contact can only be identified micropaleontologically. (translation)

Contreras and Castillón (1968, p. 249) state that:

> The Miocene [*sic*] has been divided into formations on the basis of lithology, down to the base of the Filisola. The upper Concepcion, lower Concepcion and Encanto Formations are subdivided on the basis of the foraminiferal faunas.

The contacts between the upper and lower Concepcion formations have been determined on the basis of foraminifers. The three formations are lithologically homogeneous, consisting of sandy shales (Sansores and Flores-Covarrubias, 1972b, p. 5).

The above references and my own field observations suggest that the upper and lower Concepcion and Encanto cannot be separated on the basis of lithology, but only by their characteristic microfaunas. According to Article 6b of the Code of Stratigraphic Nomenclature (ACSN, 1972, p. 6) and as adopted by various Mexican organizations in 1955:

> A unit distinguishable only by its fossils is not a rock stratigraphic unit but is properly classified as a biostratigraphic unit.

Therefore, the upper and lower Concepcion and Encanto strata are "biozones" defined by benthic guide foraminifers (ACSN, 1972, pp. 11, 12, Art. 19.21). Several authors have selected and published these guide fossils: Thalmann (1935, pp. 595–596); Romen (1955, pp. 166–167 and p. 235); and Sansores and Flores-Covarrubias (1972b, pp. 532–534) (see Text-fig. 8).

For the present study, the benthic foraminiferal subdivisions as outlined by Sansores and Flores-Covarrubias (1972b) are used to recognize the Concepcion and Encanto "biozones". These are the most current and correspond with Excursion C-7, of Viniegra *et al.* (1956) and others. Geologic maps from Excursion C-7 are used as a basis for field relationships in the present investigation.

Each of the three "biozones" can be recognized by its characteristic benthic assemblages and each is herein assigned to an equivalent assemblage zone. These assemblage zones are dated by planktic foraminifers and calcareous nannoplankton.

MIOCENE STRATA

Two Miocene formations occur in the study area, the Deposito and the LaLaja. These formations were designated as late Oligocene by Thalmann (1935) and Gibson (1936). Sansores and Flores-Covarrubias (1972b) kept the LaLaja Formation in the late Oligocene while subdividing the Deposito Formation into lower (early Miocene) and upper (middle Miocene) subunits. Akers (1980) placed the LaLaja Formation in the early Miocene (N.8), and the Deposito Formation in N.11 (middle Miocene) (Text-fig. 7).

Both formations are deep-water units representing a middle–lower slope environment with typical deep-water benthic foraminifers such as: *Cibicides wuellerstorfi* (Schwager, 1866), *Cibicides rugosus* Phleger and Parker, 1951, *Uvigerina rustica* Cushman and Edwards, 1938, *Pleurostomella* sp. and *Osangularia* sp.

Each formation contains common to abundant Radiolaria in some zones. The lithology of the LaLaja and Deposito in the study area is distinctive, differing from the Pliocene strata above by being more indurated, possessing distinct bedding, and having interspersed ash layers.

SALT DOMES

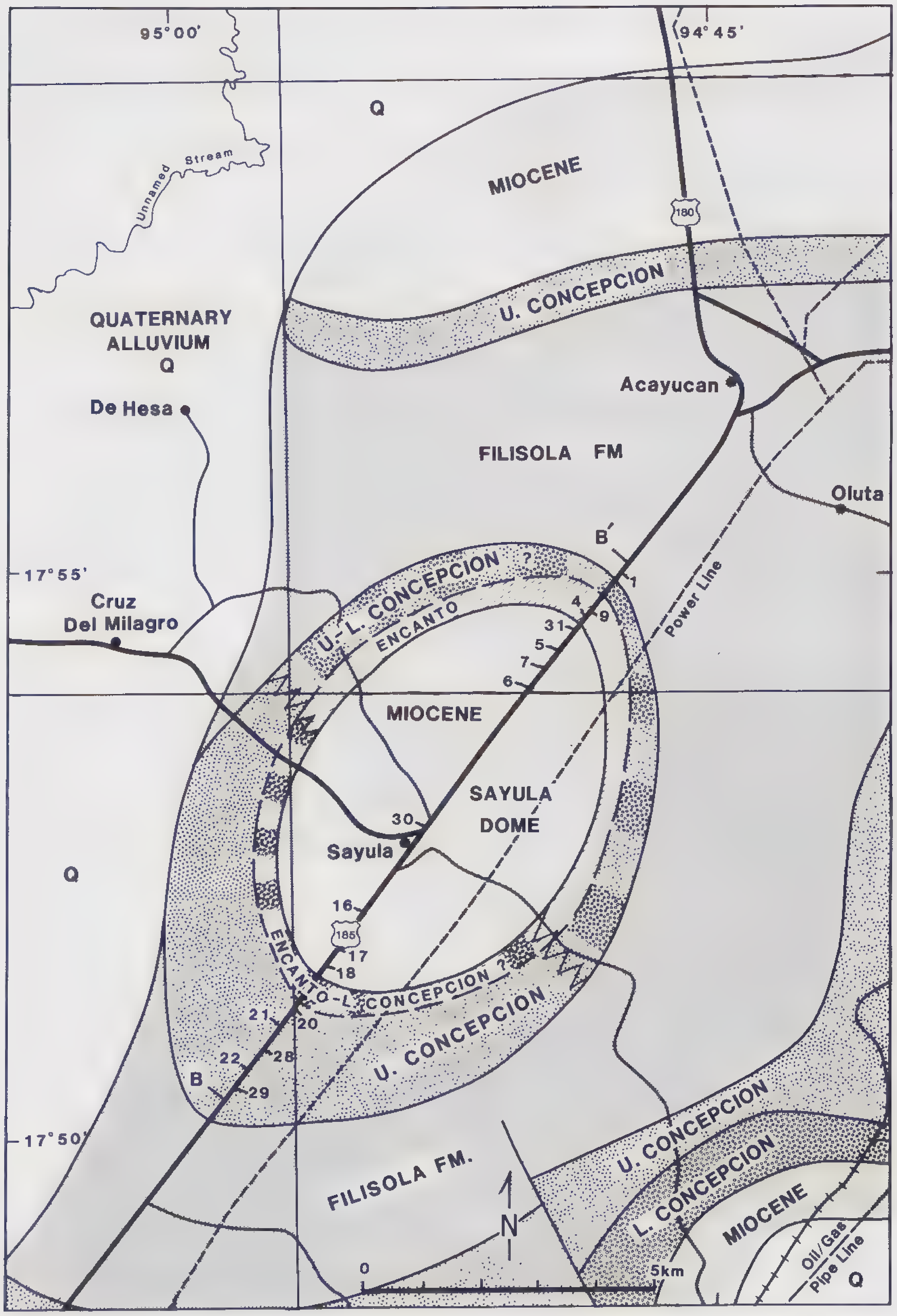
Potrerillos Dome

The outcrop pattern of the Miocene strata at the Potrerillos Dome is a narrow northeast–southwest trending, doubly-plunging anticline. The oldest deposits encountered in traverse A–A′, along Highway 180, comprise a band of Miocene strata 1.3 km in width (see Text-fig. 10). W. H. Akers (oral commun., 1983) has dated these strata exposed at Stop 2 of Excursion C-7 using planktic foraminifers and calcareous nannoplankton (Stop 2 is the same as loc. TU 1151,

1		2	3
“BIOZONES”		THALMANN (1935)	ROMEN (1955)
CONCEPCION	UPPER	**Bolivina subaenariensis** Cushman **Chilostomella mexicana** Nuttall **Cibicides filisolaensis** Nuttall **Epistomina elegans** d'Orbigny **Gyroidina soldanii** d'Orbigny **Marginulina pecketi** Schrodt **Marginulina pecketi** var. **spinosa** Schrodt **Marginulina hirsuta** d'Orbigny **Siphogenerina transversa** Cushman **Textularia mississippiensis** Cushman	**Bolivina nobilis** Hantken **Cibicides filisolaensis** Nuttall **Robulus vaughani** (Cushman) **Saracenaria limbata** (Flint) **Siphonina jacksonensis** var. **limbosa** Cushman **Bulimina mexicana** Cushman **Bulimina ovata** d'Orbigny **Eponides umbonatus** Reuss **Rectuvigerina transversa** (Cushman) **Sigmoilina schlumbergeri** Silvestri **Textularia** aff. **T. ponderosa** Fornasini
	LOWER		**Cassidulina subglobosa** Brady **Lagenonodosaria hirsuta** (d'Orbigny) **Marginulina marginulinoides** (Goes)
ENCANTO	UPPER	(IXHUATLAN STRATA) **Bolivina floridana** Cushman **Cibicides floridanus** (Cushman) **Ceratobulimina contraria** (Reuss) **Nodogenerina knihnitziana** (Karrer) **Uvigerina auberiana** d'Orbigny **Uvigerina canariensis** d'Orbigny	**Chilostomella mexicana** Nuttall **Cibicides** cf. **C. lucidus** (Reuss) **Cibicides** aff. **C. mantaensis** Galloway and Morrey **Cibicides trinitatensis** (Nuttall) **Hopkinsina notohispida** Finlay **Karreriella bradyi** Cushman **Nonion affinis** Reuss **Planulina** aff. **P. wuellerstorfi** Schwager **Pseudoglandulina comatula** Cushman **Siphotextularia concava** Brady **Sphaeroidina bulloides** d'Orbigny
	LOWER		**Angulogerina eximia** Cushman and Jarvis **Bolivina floridana** Cushman **Ceratobulimina contraria** Reuss **Chilostomella mexicana** Nuttall **Cibicides robertsonianus** Brady **Cibicides** aff. **C. lucidus** (Reuss) **Cibicides** aff. **C. mantaensis** Galloway and Morrey **Nonion pompilioides** (Fichtell and Moll) **Pseudoglandulina comatula** Cushman **Uvigerina encantoensis** Nuttall **Uvigerina laviculata** Coryell and Rivero

Text-figure 8.—Diagnostic benthic foraminifera of the Encanto and Concepcion “biozones”. Species used in subsequent figures were selected from column 5. The following abbreviations are used for relative abundance in column 5; A—abundant, C—common, F—frequent, R—rare, and VR—very rare.

4	5
VINIEGRA (1956)	**SANSORES & FLORES-COVARRUBIAS (1972 b)**
Bulimina mexicana (Cushman) **Bulimina ovata** d'Orbigny **Rectuvigerina transversa** (Cushman) **Saracenaria** aff. **S. limbata** (Flint) **Textularia** aff. **T. mexicana** (Cushman)	FIRST OCCURRENCES (SPECIES ABSENT IN FILISOLA AND AGUEGUEXQUITE) **Bolivina plicatella** Cushman . . . F **Brizalina semistriata** (Hantken) . . . C **Brizalina subaenariensis** var. **mexicana** (Cushman) . . . A **Bulimina striata** d'Orbigny . . . C **Buliminella subfusiformis** Cushman . . . C **Cibicidoides miocenica** (Colom) . . . C **Gyroidinoides altiformis** (Stewart and Stewart) . . . C **Hanzawaia isidroensis** (Cushman and Renz) . . . F **Lenticulina clericii** (Fornasini) . . . C **Planulina ariminensis** d'Orbigny . . . F **Planulina filisolaensis** (Nuttall) . . . F **Planulina harangensis** Cushman and Ellisor . . . C **Pseudoclavulina mexicana** (Cushman) . . . C **Rectuvigerina senni** (Cushman) . . . C **Saracenaria nuttalli** Sansores and Flores-Covarrubias . . . C **Saracenaria toddae** Bermudez . . . R **Textularia bermudezi** Cushman and Todd . . . F **Vaginulina alazanensis** Nuttall . . . VR
Cibicides trinitatensis (Nuttall) **Marginulina marginulinoides** (Goes)	SPECIES OCCURRING IN LOWER CONCEPCION BUT ABSENT IN UPPER CONCEPCION **Amphicoryna hirsuta** (d'Orbigny) . . . C **Anomalinoides trinitatensis** (Nuttall) . . . A **Brizalina marginata** (Cushman) . . . R **Hoeglundina elegans** (d'Orbigny) . . . A **Marginulinopsis goajiraensis** Becker and Dusenbury . . . F **Marginulinopsis messinae** (Souaya) . . . F **Marginulinopsis marginulinoides** (Goes) . . . C **Planulina wuellerstorfi** (Schwager) . . . VR **Sphaeroidina bulloides** d'Orbigny . . . C
Cyclammina cancellata Brady **Glandulina laevigata** var. **subornata** Fornasini **Gyroidina girardana** (Reuss) **Hopkinsina notohispida** Finlay	SPECIES OCCURRING IN LOWER CONCEPCION BUT ABSENT IN UPPER CONCEPCION **Allomorphina macrostoma** Karrer . . . R * **Bolivina costata** d'Orbigny . . . R * **Bolivina floridana** Cushman . . . F * **Bolivinita quadrilatera** (Schwager) . . . R * **Chilostomella mexicana** Nuttall . . . R * **Ceratobulimina alazanensis** Cushman and Harris . . . R * **Cibicidoides mundula** (Brady, Parker and Jones) . . . VR * **Cibicidoides robertsonianus** (Brady) . . . F * **Cyclammina cancellata** Brady . . . A **Gyroidinoides girardana** (Reuss) . . . A * **Heterolepa dutemplei** (d'Orbigny) . . . F **Karreriella chilostoma** (Reuss) . . . C **Karreriella bradyi** (Cushman) . . . R **Laticarinina pauperata** (Parker and Jones) . . . R * **Martinottiella communis** (d'Orbigny) . . . F **Melonis affinis** (Reuss) . . . A **Melonis pompilioides** (Fichtel and Moll) . . . F * **Nodosaria stainforthi** Cushman and Renz . . . C * **Osangularia bengalensis** (Schwager) . . . R **Planulina mantaensis** (Galloway and Morrey) . . . C * **Planulina thiaracuta** (Hornibrook) . . . F * **Pseudonodosaria comatula** (Cushman) . . . F * **Pseudonodosaria tenuistriata** (Bermudez) . . . R * **Siphotextularia concava** (Karrer) . . . R * **Siphouvigerina auberiana** (d'Orbigny) . . . A * **Textularia hauerii** d'Orbigny . . . C * **Uvigerina bermudezi** Acosta . . . R **Uvigerina laviculata** Coryell and Rivero . . . F * SPECIES RESTRICTED TO ENCANTO
	SPECIES OCCURRING ONLY IN LOWER ENCANTO **Lagena asperoides** Galloway and Morrey . . . VR **Osangularia culter** (Parker and Jones) . . . R **Stilostomella paucistriata** (Galloway and Morrey) . . . VR **Truncatulina spirata** Seguenza . . . C **Uvigerina gallowayi** Cushman . . . C



and loc. PD-62 of the present investigation). Akers assigned the LaLaja Formation here to Zone N.8 (late early Miocene).

Pliocene Encanto and lower Concepcion strata were sampled at 21 sites on the east flank of the dome, a total thickness of approximately 730 m calculated from average dip rates shown on maps of Excursion C-7. Eighteen samples were collected on the west flank, where all three Pliocene units are exposed in a total thickness of 945 m.

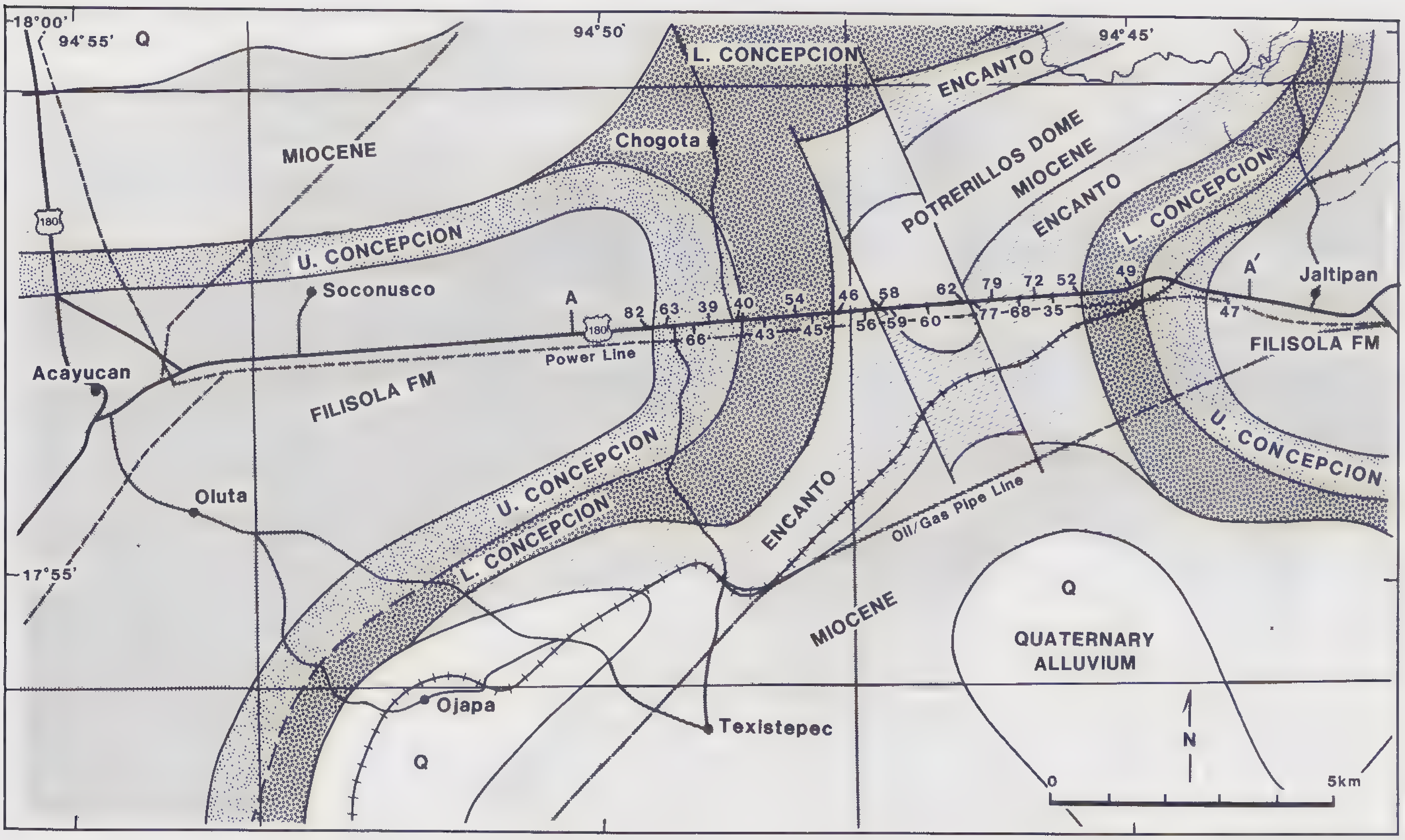
Sayula Dome

The Sayula Dome, a much larger feature than the Potrerillos Dome, also trends northeast–southwest but has a broader Miocene outcrop pattern (Text-fig. 9). Miocene strata crop out along Highway 185 for approximately 6.5 km along traverse B–B'.

The Miocene strata at localities TU 1139 (=SD-6) and TU 1140 (=SD-18) have been dated by Akers (oral commun., 1983) using planktic foraminifers and calcareous nannoplankton. He has assigned the strata to Zone N.10 (middle Miocene), equating them with the Deposito Formation.

The Encanto beds, approximately 210 m thick, are the only marine Pliocene strata encountered on the north flank of the Sayula Dome. Nine samples were collected.

Five samples of upper Concepcion strata, having an inferred thickness of 685 m were collected on the south flank of the Sayula Dome. Encanto and lower Con-



Text-figure 9.—Geologic map of the Sayula Dome, southwest of Acayucan, Veracruz, with sample localities along traverse B–B′. Localities are described in the Appendix. The geologic base map is modified from Contreras (1956) and redrawn on the Acayucan Quadrangle map.

Text-figure 10.—Geological map of the area between Acayucan and Jaltipan, Veracruz. Traverse A–A′ crosses the Potrerillos Dome, showing the sample localities used in this study. These localities are described in the Appendix. The geologic map is modified from Contreras (1956) and redrawn on the Acayucan Quadrangle Map.

Legend for Text-figures 9 and 10

- Q Quaternary
- ▦ Filisola Formation
- ⁘ Upper Concepcion "Biozone"
- ⁙ Lower Concepcion "Biozone"
- ☐ Encanto "Biozone"
- ▧ ? Upper – Lower Concepcion "Biozone"
- ▨ ? Encanto – Lower Concepcion "Biozone"
- ▤ Miocene (Deposito and LaLaja formations)
- F——F′ Fault
- ┼┼┼┼ Railroad

cepcion strata were not encountered in outcrops on the south flank.

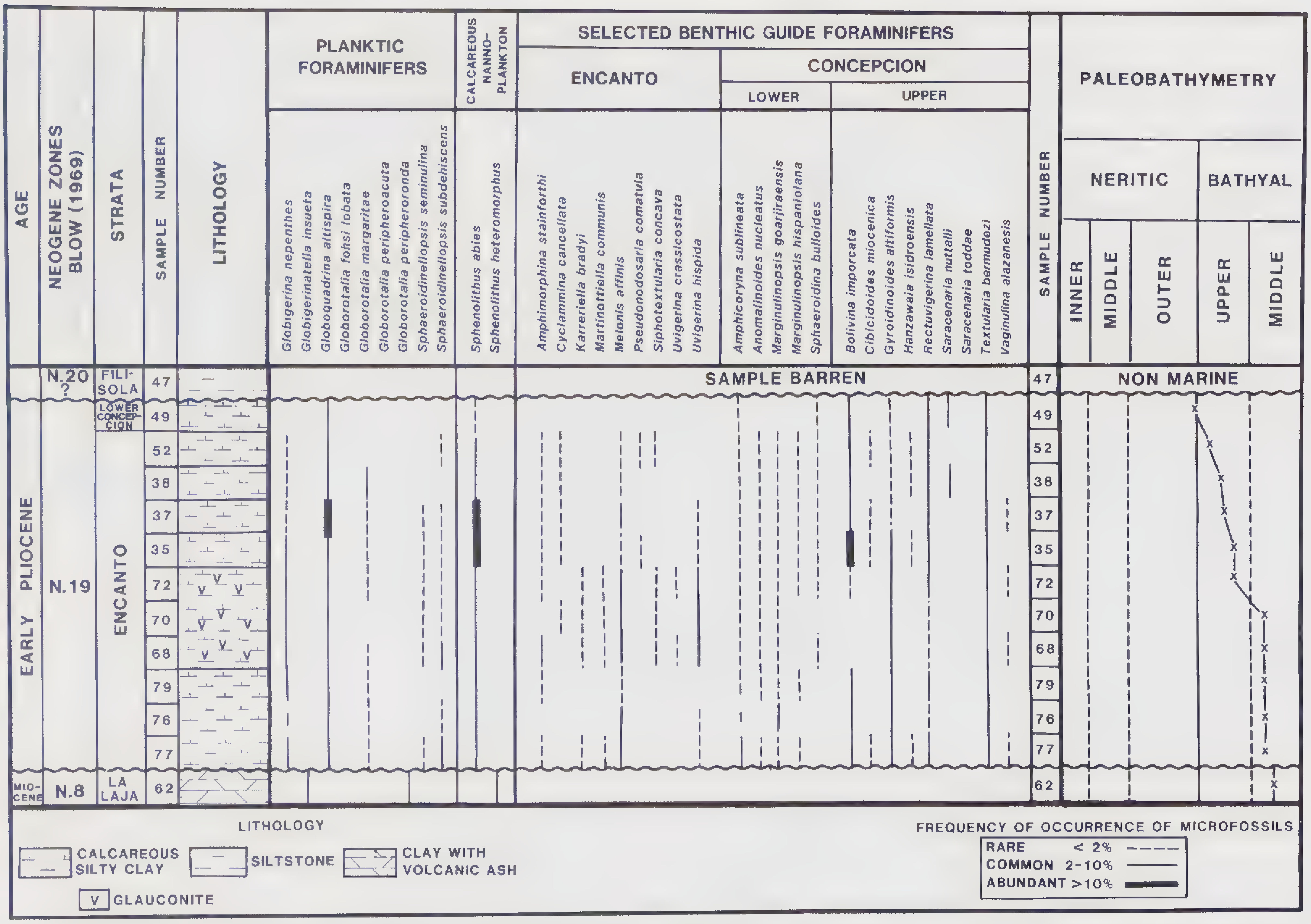
CONTACT RELATIONSHIPS OF THE MIOCENE AND PLIOCENE STRATA

On the north flank of the Sayula Dome, the Encanto strata overlie the middle Miocene Deposito Formation (Text-fig. 13). On the south flank (Text-fig. 14) the Deposito Formation is overlain by upper Concepcion strata.

In sections across the Potrerillos and Sayula domes (Text-figs. 11–14), the interval between the early Pliocene and middle Miocene (Zones N.4–18) was not encountered and is presumed to be missing. Contreras and Castillón (1968, p. 260) note, furthermore, that there is an angular unconformity in the western part of the Salina Basin between the Deposito and LaLaja strata and the overlying Encanto and Concepcion strata, and suggest that this portion of the Basin was above sea level during the upper Miocene.

BIOSTRATIGRAPHIC CHARTS

Twenty representative samples were selected from the composite section and used to produce the benthic foraminiferal distribution chart (Text-fig. 15). All of the benthic species found in these samples are displayed on this chart, and they are also included in the systematics section of this investigation. Each occur-



Text-figure 11.—Occurrence chart of selected microfossils from the east flank of the Potrerillos Dome. The non-marine Filisola Formation overlies the lower Concepcion "biozone" while the early Pliocene Encanto "biozone" overlies the middle Miocene La Laja Formation. Paleobathymetric interpretation is based on the total foraminiferal assemblage.

rence is noted as the percent of the total benthic population of a given sample.

The summary data from the two traverses, A–A′ and B–B′, are shown in Text-figures 11–14. Traverse A–A′ is divided into two segments, one on the east flank of the Potrerillos Dome (Text-fig. 11) and one on the west flank (Text-fig. 12). Traverse B–B′ is also divided into segments: the north flank of the Sayula Dome (Text-fig. 13), and the south flank (Text-fig. 14).

Planktic Foraminifers

Occurrences of key planktic foraminifers are shown in Text-figures 11–14. This is a partial list of taxa identified by the writer from Pliocene and Miocene samples in the study area.

Globigerina nepenthes Todd, 1957
**Globigerinatella insueta* Cushman and Stainforth, 1945
Globoquadrina altispira altispira (Cushman and Jarvis, 1936)
**Globorotalia* (*Globorotalia*) *fohsi* forma *lobata* Bermudez, 1949
Globorotalia (*Globorotalia*) *margaritae* Bolli and Bermudez, 1965
**Globorotalia peripheroacuta* Blow and Banner, 1966
**Globorotalia* (*Turborotalia*) *peripheroronda* Blow and Banner, 1966
Sphaeroidinellopsis seminulina seminulina (Schwager, 1866)
Sphaeroidinellopsis subdehiscens subdehiscens (Blow, 1959)

These index species define some of the Pliocene and Miocene zones of Blow (1969), as modified by Berggren (1973) and Berggren and Van Couvering (1974). A complete list of planktic foraminifers from Tulane University localities of Pliocene age can be found in Akers (1979).

Calcareous Nannoplankton

The calcareous nannoplankton zonations of Martini (1971) and Gartner (1973) are used in this study. Calcareous nannoplankton from each sample were reviewed by the writer for the presence of index species. Two key species identified therein assisted in dating the Pliocene and Miocene samples. These are: *Sphenolithus abies* Deflandre, 1954 and *Sphenolithus heteromorphus* Deflandre, 1953. The calcareous nannoplankton were used with the planktic foraminifers to determine the age of the strata (see Text-fig. 7).

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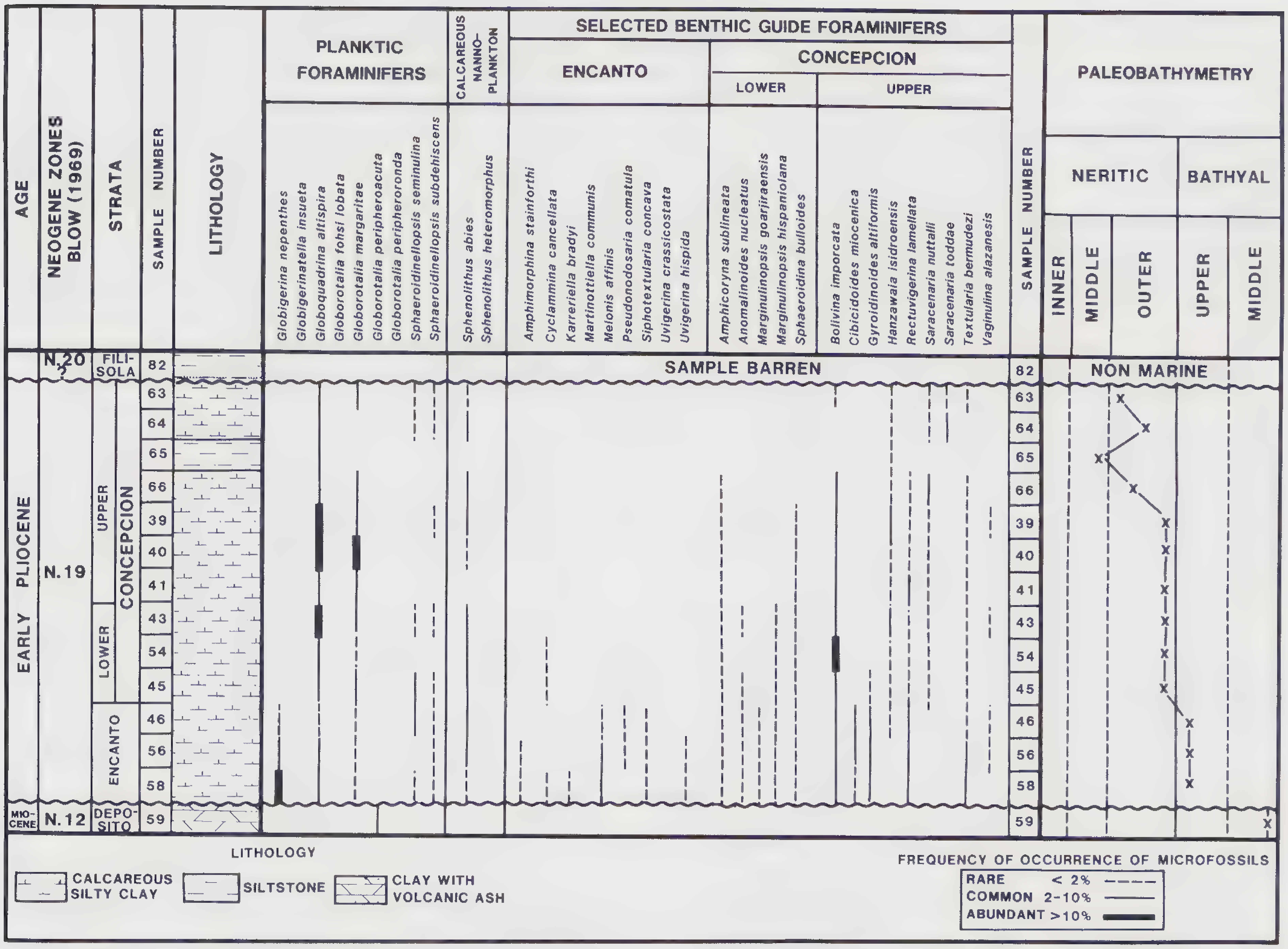
* Miocene species.



Text-figure 12.—Occurrence chart of selected microfossils from the west flank of the Potrerillos Dome. The non-marine Filisola Formation overlies the upper Concepcion "biozone" and the early Pliocene Encanto "biozone" overlies the middle Miocene Deposito Formation.

Akers (1979) and Akers and Koeppel (1973) include detailed lists of occurrences of calcareous nannoplankton in the Concepcion and Encanto strata of the Salina Basin.

Benthic Foraminifers

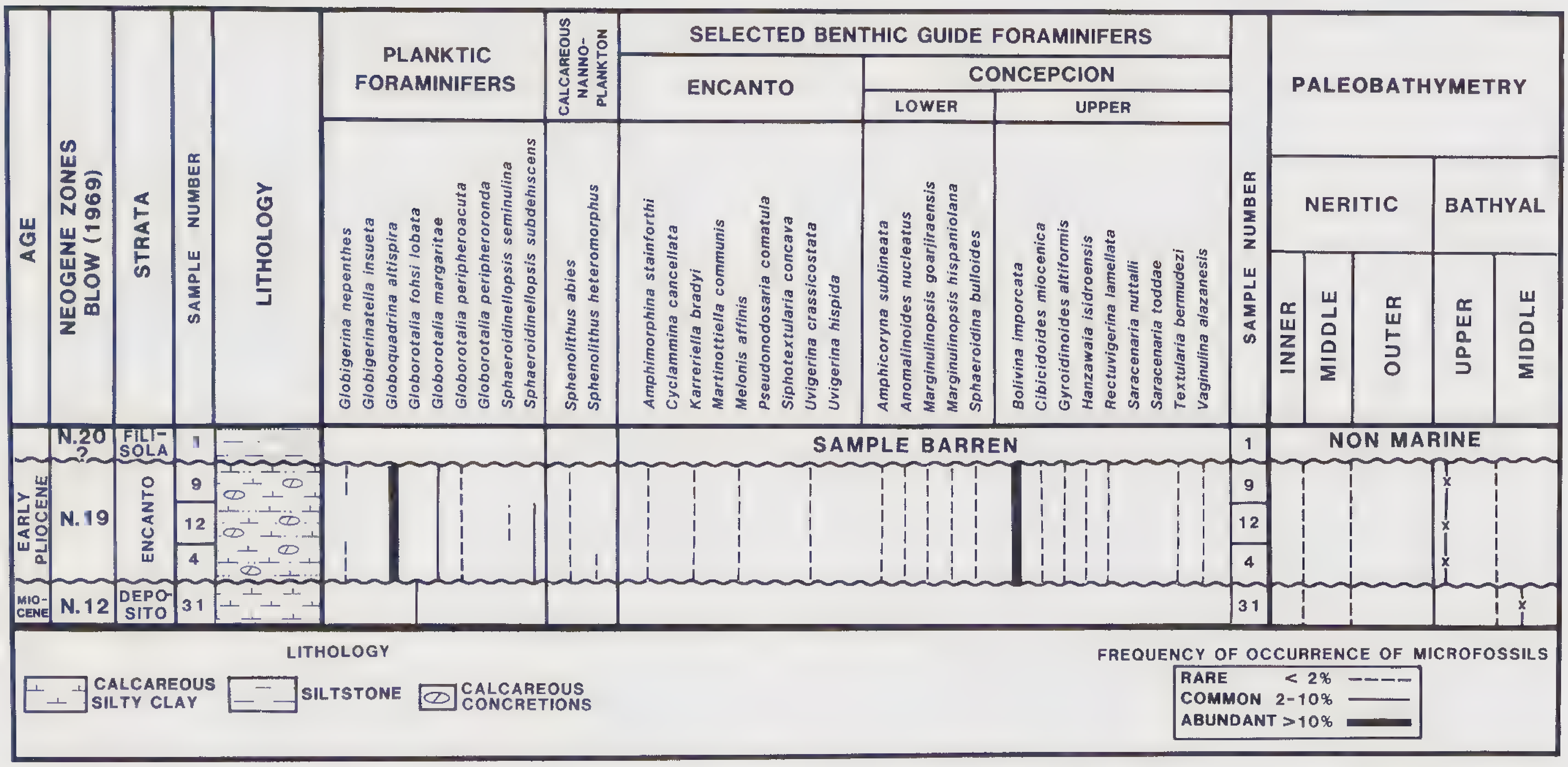
Benthic foraminifers are used in the Salina Basin by Mexican paleontologists to recognize strata that cannot be differentiated on the basis of lithology. Sansores and Flores-Covarrubias (1972b, pp. 532–534) have compiled the most up-to-date distribution chart for those benthic foraminifers used to distinguish various biozones and formations in the Basin. Their distribution charts were used as a guide in this study. Distinctive benthic foraminifers from these charts representing the Concepcion and Encanto "biozones" are shown in Text-figure 8.

After studying the distribution of benthic foraminifers from samples in the study area, 23 species were selected from those listed in Text-figure 8. These species are considered herein to be diagnostic of each of the three biozones and are shown in Table 1. Eight taxa listed by Sansores and Flores-Covarrubias have been assigned by the writer to different species. The list (with changes) is used in Text-figures 11 through 14.

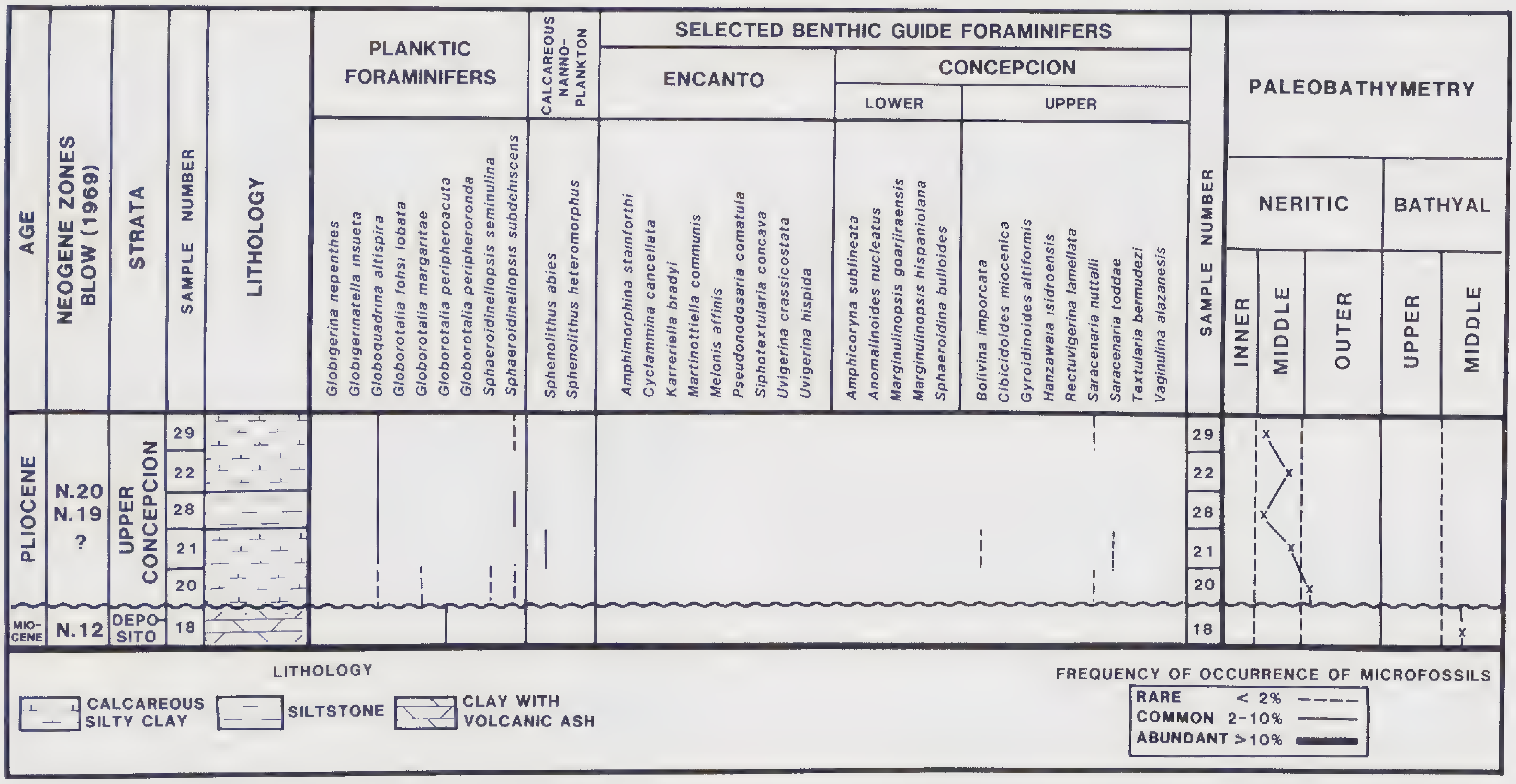
Once the benthic foraminiferal criteria were determined from the lists and sample studies, the calcareous nannoplankton and planktic foraminiferal distributions could be determined for each biozone. The distribution of selected planktic and benthic foraminifers and calcareous nannoplankton for each sample in the Potrerillos and Sayula domes are included in Text-figures 11 through 14.

PALEOENVIRONMENT

Studies of the modern distribution of shelf and slope benthic foraminifers of the Gulf of Mexico have been published by Culver and Buzas (1981, 1983), Pflum and Frerichs (1976), Phleger (1960), Phleger and Parker (1951), Poag (1981), Walton (1964), and others. Many of the benthic species found in the three biozones are still living in the Gulf of Mexico and provide the



Text-figure 13.—Occurrence chart of selected microfossils from the north flank of the Sayula Dome. The non-marine Filisola Formation overlies the Encanto "biozone" while the early Pliocene Encanto "biozone" overlies the middle Miocene Deposito Formation. The rare occurrences of *Globorotalia peripheroacuta* and *Sphenolithus heteromorphus* are reworked from Miocene sediments.



Text-figure 14.—Occurrence chart of selected microfossils from the south flank of the Sayula Dome. The early Pliocene, upper Concepcion "biozone" overlies the middle Miocene Deposito Formation. The lower Concepcion and Encanto "biozones" were not encountered at sampling sites on the south flank.

basis for the paleoenvironmental interpretations used herein. Bathymetric zonation used is adapted from Tipsword, Setzer, and Smith (1966, p. 122) and Pflum and Frerichs (1976). The shelf is divided into inner neritic (0–20 m), middle neritic (20–100 m), outer neritic (100–200 m), and the slope into upper bathyal (200–500 m), middle bathyal (500–1000 m), and lower bathyal (1000–2000 m).

Table 1.—Twenty-three benthic foraminifers selected from Text-figure 8 represent key benthic species from the three Pliocene "biozones" in the study area. Taxa with name changes used in the present study are shown in the right column. These key benthic foraminifers are used in Text-figures 11 through 14. Eleven of the diagnostic species (marked by an asterisk [*]) are extant.

Forms listed by Sansores and Flores-Covarrubias (1972b)	Forms listed in present study
Upper Concepcion "biozone"	
Bolivina plicatella Cushman	*Bolivina imporcata* Cushman and Renz
Cibicidoides miocenica (Colom)	no change
**Gyroidinoides altiformis* (Stewart and Stewart)	no change
Hanzawaia isidroensis (Cushman and Renz)	no change
Rectuvigerina senni (Cushman)	*Rectuvigerina lamellata* (Cushman)
Saracenaria nuttalli Sansores and Flores-Covarrubias	no change
Saracenaria toddae Bermudez	no change
Textularia bermudezi Cushman and Todd	no change
Vaginulina alazanensis Nuttall	no change
Lower Concepcion "biozone"	
**Amphicoryna hirsuta* (d'Orbigny)	*Amphicoryna sublineata* (Brady)
**Anomalinoides trinitatensis* (Nuttall)	*Anomalinoides nucleatus* (Seguenza)
Marginulinopsis goajiraensis Becker and Dusenbury	no change
Marginulinopsis messinae (Souaya)	*Marginulinopsis hispaniolana* (Bermudez)
**Sphaeroidina bulloides* d'Orbigny	no change
Encanto "biozone"	
Nodosaria stainforthi Cushman and Renz	*Amphimorphina stainforthi* (Cushman and Renz)
**Cyclammina cancellata* Brady	no change
**Karreriella bradyi* (Cushman)	no change
**Martinottiella communis* (d'Orbigny)	no change
**Melonis affinis* (Reuss)	no change
**Pseudonodosaria comatula* (Cushman)	no change
**Siphotextularia concava* (Karrer)	no change
Uvigerina gallowayi Cushman	*Uvigerina crassicostata* Schwager
**Siphouvigerina auberiana* (d'Orbigny)	*Uvigerina hispida* Schwager

In the present study, the Pliocene shelf–slope break is assumed to coincide generally with the 200 m isobath of the modern Gulf of Mexico. There is probably a difference in water depth between the ancient and modern shelf edges, but since the 200 m isobath can be recognized by its distinctive benthic foraminiferal assemblage (Pflum and Frerichs, 1976), this paleo water depth can be utilized as a shelf–slope boundary indicator.

Poag (1981) and Culver and Buzas (1983) observed that benthic assemblages (predominant genera and diagnostic species associations) have a concentric pattern following the bathymetric contours in the Gulf of Mexico. Poag (1981) mapped generic predominance facies that show a direct relationship to bathymetry, although he suggests there is indirect evidence that several generic predominance facies may be associated with the oxygen minimum layer.

The modern relationship between generic distribution and ecologic parameters such as salinity, temperature, substrate, and water-mass composition is not clear; therefore, most authors use water depth as a method of expressing the distribution of benthic foraminiferal facies.

Twenty samples shown in Text-figure 15 are used as the data base for detailed analysis of benthic fauna and paleoenvironmental interpretation. Predominant genera are displayed in Text-figure 16.

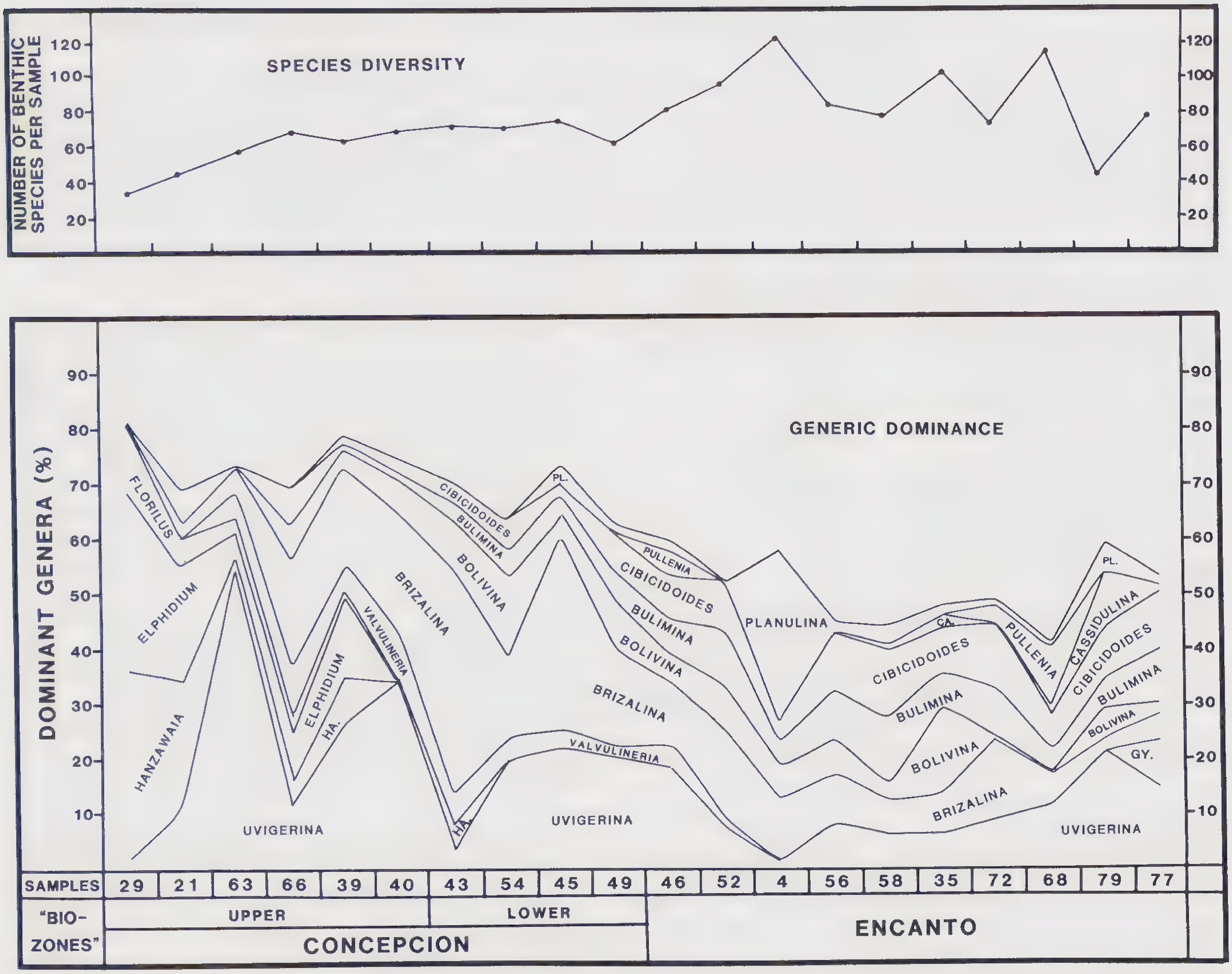
Text-figure 16 illustrates changes in generic dominance from the Encanto "biozone" through the upper Concepcion "biozone". The three dominant genera comprise approximately 30 percent of the benthic population in the Encanto and over 60 percent in the upper Concepcion. Change in character of dominant genera, distribution of species having known shallow depth limits, and species diversity are all used to determine the paleoenvironment of each of the samples charted in Text-figure 15.

A summary of the paleoenvironments for the Encanto and Concepcion biozones is shown in Text-figure 17. Shallowing of the paleobathymetry is clearly illustrated in this figure.

Paleobathymetry for each traverse across the Potrerillos and Sayula domes is shown in Text-figures 11 through 14.

BIOZONES

Since the Encanto and Concepcion strata are neither proper lithostratigraphic units nor properly-named biostratigraphic units (NACSN, 1983), they have been redefined herein as assemblage zones, as recommended by Article 21, ACSN (1972). Three assemblage zones corresponding to the upper and lower Concepcion and Encanto "biozones" are shown in Text-figure 18. Ranges of the key benthic foraminifers are related to the Neogene Zones of Blow (1969). Ranges of the key benthic foraminifers are related to the Neogene Zones of Blow (1969). These key benthic foraminifers are recognized by the writer to be diagnostic of each of the assemblage zones.



Text-figure 16.—16a. Species diversity for the three "biozones". The species diversity averages 59 for the upper Concepcion "biozone", 73 for the lower Concepcion "biozone", and 89 for the Encanto "biozone", increasing to the right with the increase in paleo water depth (see Text-fig. 17); 16b. Cumulative percent of 14 dominant genera for the three "biozones". The following abbreviations are used: Ha = *Hanzawaia*; Ca = *Cassidulina*; Pl = *Planulina.*

Note: Data points are plotted at the midpoint of each sample—there is no change in percent within a sample. Data from distribution chart (Text-fig. 15).

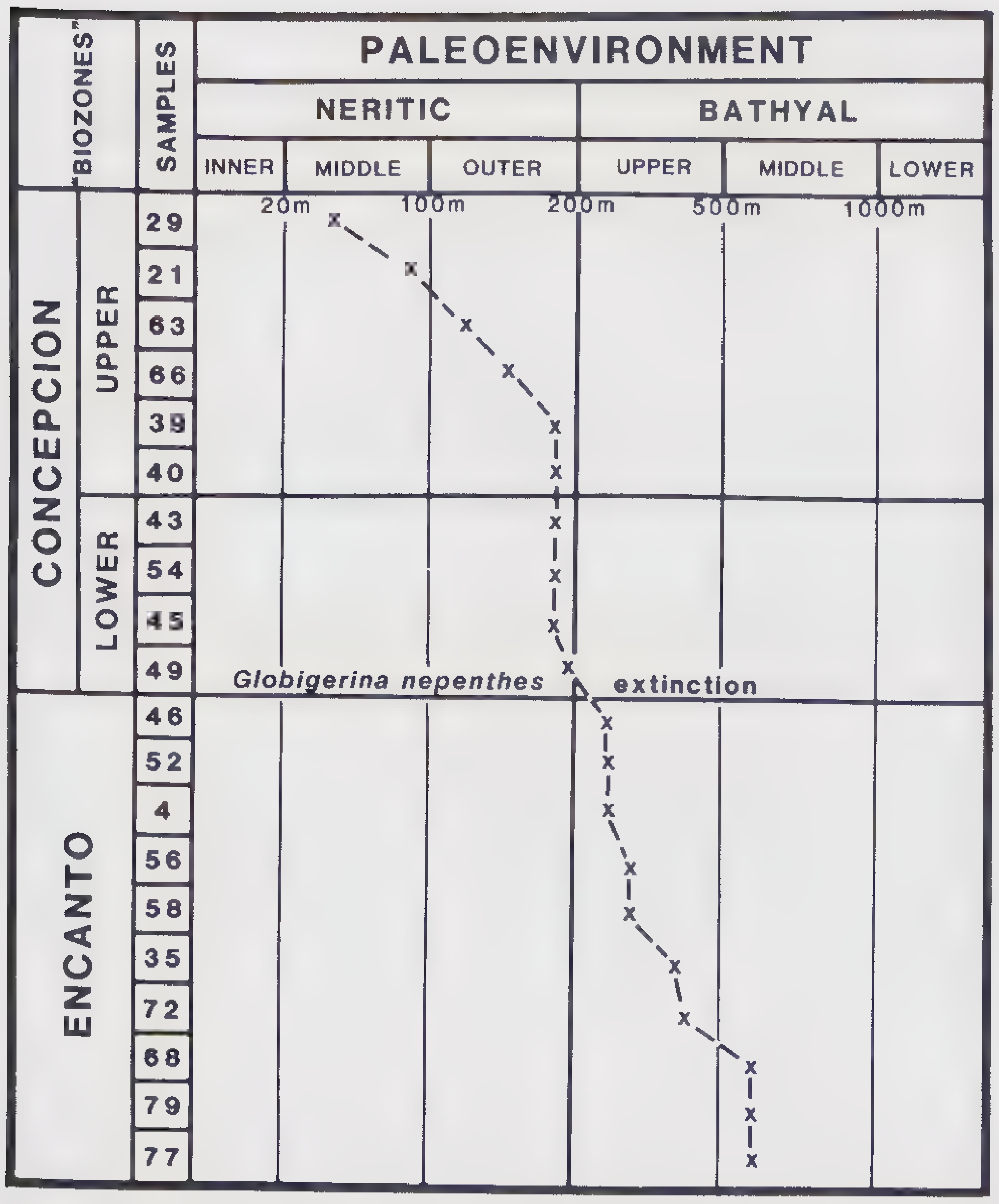
Melonis affinis–Uvigerina hispida Assemblage Zone

The Encanto "biozone" in the study area can be recognized by the occurrence of *Melonis affinis* (Reuss, 1851) and *Uvigerina hispida* Schwager, 1866. These species occur in younger sediments in offshore Louisiana and Texas wells and elsewhere, and their absence in the overlying Concepcion "biozone" represents a local disappearance—not an extinction.

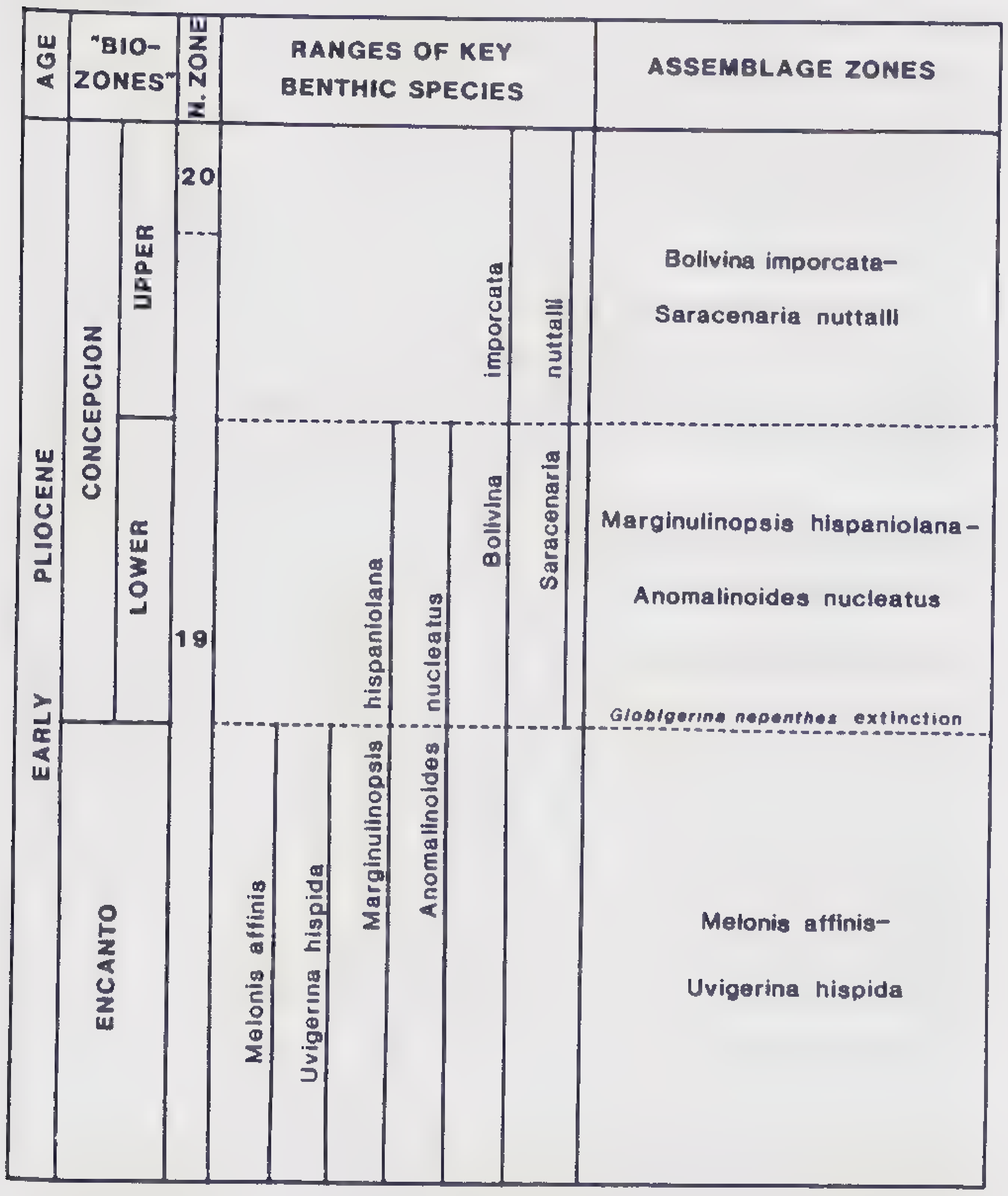
The planktic foraminifer *Globigerina nepenthes* Todd, 1957, however, does become extinct near the top of the Encanto "biozone". This extinction has been placed by Berggren (1973) in the early Pliocene (later portion of Zone N.19 of Blow, 1969). An age of 3.7 my has been used by Berggren (1973) for the extinction of *G. nepenthes.*

Benthic foraminiferal assemblages of the Encanto "biozone" imply ancient water depths of 300 to 700 m (upper to middle bathyal). The lithology is generally a calcareous silty clay that is slightly glauconitic in samples from localities PD-68, 70, and 72 and contains calcareous nodules in samples from localities SD-4, 9, and 12.

The benthic faunal constituents at locality SD-4, equivalent to locality TU 1083, exhibit faunal mixing. It is concluded that a shelf faunule of attached, nearshore benthic foraminifers was displaced into an upper bathyal environment.



Text-figure 17.—Summary of the paleoenvironment of early Pliocene "biozones" in the study area. The extinction of *Globigerina nepenthes* (3.7 my) precedes the closure of the Isthmus of Panama at 3.5 my.



Text-figure 18.—Three assemblage zones based on ranges of key benthic foraminifers. The upper boundary of the Encanto "biozone" is marked by the extinction of *Globigerina nepenthes.*

This is supported by the high abundance (28% of the total benthic faunal assemblage) of *Planulina exorna* Phleger and Parker, 1951. According to Phleger and Parker (1951), this species is restricted to depths of less than 100 m in the Recent Gulf of Mexico.

Sessile foraminifers such as *Montfortella* Loeblich and Tappan, 1963, *Dyocibicides* Cushman and Valentine, 1930, *Cibicides* Montfort, 1808, *Carpenteria* Gray, 1858, *Planorbulinella* Cushman, 1927a and an abundance of highly abraded specimens of *Amphistegina* d'Orbigny, 1826 are found at this locality. Several individuals of *Dyocibicides* and *Montfortella* have a "pseudo-acervuline" shape and appear to have been attached to seaweeds (Kohl and Haman, 1980). Large, abraded echinoid spines are also abundant. Akers (1979) gives a comprehensive list of planktic foraminifers and calcareous nannoplankton occurring at locality TU 1083.

Locality SD-4 also has rare occurrences of Miocene planktic and benthic foraminifers. *Globorotalia peripheroacuta* Blow and Banner, 1966, which ranges from Zone N.10 to N.12, is found with Miocene benthic foraminifers that Sansores and Flores-Covarrubias (1972b) note are restricted to the Deposito Formation. The older foraminifers were probably eroded from Miocene sediments exposed during the early Pliocene and redeposited at locality SD-4.

Marginulinopsis hispaniolana–Anomalinoides nucleatus Assemblage Zone

The lower Concepcion "biozone" can be recognized by the presence of *Marginulinopsis hispaniolana* (Bermudez, 1949) and *Anomalinoides nucleatus* (Seguenza, 1880), and by the absence of the Encanto species, *Melonis affinis* (Reuss, 1851) and *Uvigerina hispida* Schwager, 1866. The planktic foraminifers *Globorotalia margaritae* Bolli and Bermudez, 1965, *Sphaeroidinellopsis seminulina* (Schwager, 1866), and *S. subdehiscens subdehiscens* (Blow, 1959) occur in this "biozone". The calcareous nannoplankton *Sphenolithus abies* Deflandre, 1954 is present.

The lower Concepcion "biozone" was deposited in water depths of 180 to 200 m (outer neritic). The lithology is a calcareous silty clay.

Bolivina imporcata–Saracenaria nuttalli Assemblage Zone

The upper Concepcion "biozone" can be differentiated from the lower Concepcion "biozone" by the presence of benthic species *Bolivina imporcata* Cushman and Renz, 1944, *Saracenaria nuttalli* Sansores and Flores-Covarrubias, 1972a, and the absence of other lower Concepcion species. *Globorotalia marga-*

ritae Bolli and Bermudez, 1965 is common in deep-water facies; *Sphaeroidinellopsis seminulina* (Schwager, 1866) and *S. subdehiscens* (Blow, 1959) occur in low frequencies throughout the upper Concepcion "biozone" as does the calcareous nannoplankton *Sphenolithus abies* Deflandre, 1954.

Near the top of the upper Concepcion "biozone", especially on the south flank of the Sayula Dome, water depth shoaled to middle neritic. *Globorotalia margaritae* is absent from these samples. It is not conclusive from data in the study area whether this absence is a local disappearance or an extinction. The presence of *Sphaeroidinellopsis subdehiscens* in these samples, however, indicates that they may belong to Zone N.20. Berggren (1973) places the extinction of *S. subdehiscens* at 3.0 my, approximately the extinction datum of *Sphenolithus abies*. This would place the age of the sampled section definitely below the base of Zone N.21.

The lithology of the upper Concepcion "biozone" is similar to the lower Concepcion, a calcareous silty clay. However, the percentage of terrigenous silt in the shallow facies is appreciably greater than in the deeper water intervals. Water depth ranged from 50 to 180 m (middle to outer neritic).

Summary

1. Benthic faunal assemblages from the early Pliocene of the study area are similar to those of the northern Gulf of Mexico subsurface. Ninety-one percent of the species are common to the outer shelf and upper bathyal sediments of the subsurface Pliocene of the continental shelf of Louisiana and Texas.
2. Concepcion and Encanto "biozones" have distinctive benthic foraminiferal faunas that can be used locally to separate them into assemblage zones. However, key species of planktic foraminifers and calcareous nannoplankton are essential to give precise age dates.
3. The boundary between the lower Concepcion and Encanto "biozones" in the study area can be recognized by the extinction of *Globigerina nepenthes*, which is within Zone PL1 of Berggren (1973) and is dated as 3.7 my.
4. Early Pliocene strata in the study area exhibit a steadily decreasing paleo water depth (700 m in Encanto "biozone" to 50 m in the upper Concepcion "biozone"), indicating uplift of the Salina Basin. This uplift is related to the closure of the Isthmus of Panama (dated approximately 3.5 my).
5. Middle and late Miocene (N.13–17) and earliest Pliocene (N.18) sediments are missing from the study area. The absence of these sediments from both the Sayula and Potrerillos salt domes implies that an unconformity exists between Pliocene and Miocene strata.
6. In the study area, the non-marine Filisola Formation rests unconformably on marine sediments. It overlies the Encanto (north flank of the Sayula Dome) and the upper and lower Concepcion (west and east flank respectively of the Potrerillos Dome).

SYSTEMATIC PALEONTOLOGY

Introduction

The *Catalogue of Foraminifera* (Ellis and Messina, 1940) was used as a basis for species identification. Once the cosmopolitan nature of many of the benthic species was established, a literature search was expanded to include areas outside the Gulf of Mexico and Caribbean provinces.

An examination of available Pliocene topotype material from deepwater foraminiferal faunas having affinities to the Mexican Pliocene assisted in identifying synonyms and also aided in determining species variability from one geographical area to another.

Format

The foraminiferal classification used in this study conforms chiefly to that of Loeblich and Tappan (1964b, 1974). Genera included herein and not found in the *Treatise* (Loeblich and Tappan, 1964a) are: *Alvarezina* Bermudez and Rivero, 1963; *Cribrolenticulina* Haman, 1978; *Lernella* Saidova, 1975; *Montfortella* Loeblich and Tappan, 1963; *Rutherfordoides* McCulloch, 1981; *Sigmoilinita* Seiglie, 1965; and *Vasiglobulina* Poag, 1969.

Each species is listed alphabetically within its generic group. There are 206 species and six subspecies representing 108 genera, of which four species are new.

The synonymies include references to original descriptions, name changes, and significant discussions, and to occurrences that show the geographic and stratigraphic range of a species. Open synonymy has been kept to a minimum and is used only when a taxon cannot be placed in an existing species because of poor preservation or inadequate number of specimens.

Determination of species is based on the author's experience with Neogene foraminifers from the Louisiana and Texas subsurface. I tend to "lump" species rather than "split", a viewpoint based upon population studies and knowledge of the morphologic variation within many genera. My approach is generally conservative when erecting new species.

Each taxon listed herein has been redescribed using representative individuals from the study material, after population studies determined inter- and intraspecific variation. Scanning electron microscope [SEM] photomicrographs formed the basis for the descriptions. Details of the apertures were added as well as data from dissected specimens.

Several terms are used in the *Description* section: 1) *areal* = in the face of the ultimate chamber (*sensu* Loeblich and Tappan, 1964a) 2) *embracing* = later chambers partly covering or completely surrounding earlier chambers (overlapping).

Distribution

Distribution information generally includes geographic and stratigraphic occurrences of taxa for low latitude regions. Some taxa, however, occur in the Recent of the North Pacific and North Atlantic oceans. The study material is similar to widely distributed Pliocene foraminiferal faunas from Italy, Papua New Guinea, Japan, Fiji, and Car Nicobar (Indian Ocean). Four species from the Pliocene of Japan, *Ehrenbergina bosoensis* Takayanagi, 1951, *Siphonodosaria oinomikadoi* (Ishizaki, 1943), *S. hyugaensis* (Ishizaki, 1943), and *Stilostomella japonica* (Ishizaki, 1943), are identified for the first time in the Mexican Gulf Coastal Plain. Three species from Indonesia, previously known only from the Pacific; *Fissurina bodjonegoroensis* (Boomgaart, 1950), *Lernella inflata* (LeRoy, 1944a) and *Lernella seranensis* (Germeraad, 1946), also occur in the study material. These taxa probably entered the Gulf of Mexico before the closure of the Isthmus of Panama, which has been dated at approximately 3.5 my. One genus, *Montfortella,* previously restricted to the Pleistocene and Recent of the Pacific Ocean, has been documented from the study area (Kohl and Haman, 1980).

The distribution data include geographic and stratigraphic information. These data are not intended to be comprehensive but are presented as a guide to the reader. The following equivalents are used to express the frequency of occurrence of species in the study area: rare = less than two percent of the total benthic foraminifers; common = two to 10 percent; and abundant = greater than 10 percent.

All references to occurrences in the Concepcion and Encanto "biozones" refer to the distribution within the study area only. Occurrences outside the study area are identified separately.

Arrangement of Plates

The plates are arranged taxonomically as in the text. Scanning electron microscope [SEM] photomicrographs are used to illustrate most species. In some cases, light photomicrographs are included to show important test features not visible with the SEM.

Each figured specimen of a species is assigned a single figure number on each plate. This number is used for all views of that specimen. Generally, a minimum of three views is presented, with supplemental enlargements to show important diagnostic features.

Abbreviation of Repository Institutions

All the primary type specimens cited in the following section are reposited in the U.S. National Museum of Natural History [USNM] (Smithsonian Institution, Washington, D.C. 20560, U.S.A.). Other figured specimens reside in the author's collection.

Order **FORAMINIFERIDA** Eichwald, 1830

Suborder **TEXTULARIINA**
Delage and Hérouard, 1896

Superfamily **LITUOLACEA** Blaineville, 1825

Family **HORMOSINIDAE** Haeckel, 1894

Subfamily **REOPHACINAE** Cushman, 1910

Genus **REOPHAX** Montfort, 1808

Reophax acosta Bermudez, 1949
Plate 1, Figure 3

Reophax acosta Bermudez, 1949, p. 47, pl. 1, figs. 28–31.

Description.—Test free, rectilinear, elongate, cylindrical, slightly arcuate, initial end rounded, apertural end acute, circular in transverse section; chambers few, three in the adult, slightly inflated, slightly overlapping; sutures somewhat depressed; wall coarsely agglutinated, formed by large sand grains, well-cemented, surface rough; aperture terminal, slightly compressed, an elongate slit with a slight lip.

Discussion.—*Reophax encantoensis* Ayala, Eternod, and Castillo, 1954, from the Encanto "biozone" of the Veracruz Basin, may be a junior synonym of *R. acosta.*

Distribution.—*Reophax acosta* was originally described from the middle Pliocene (Mao Formation) of the Dominican Republic. It is very rare in the study area, found only at locality PD-43 in the lower Concepcion "biozone".

Family **LITUOLIDAE** Blaineville, 1825

Subfamily **HAPLOPHRAGMOIDINAE**
Mayne, 1952

Genus **HAPLOPHRAGMOIDES** Cushman, 1910

Haplophragmoides species A
Plate 1, figure 1

Description.—Test free, planispiral, involute, compressed, periphery acute; chambers distinct, eight in the final whorl, increasing gradually in size, each chamber slightly depressed near each suture; sutures radial to slightly curved, flush with surface; wall finely agglutinated with some quartz grains scattered throughout; aperture indistinct.

Discussion.—*Haplophragmoides* sp. A exhibits some of the features of *H. carinatum* Cushman and Renz, 1941, with the depressed chamber walls and acute periphery, but it lacks the distinct keel and the smooth agglutinated wall.

Distribution.—This species is rare in the study area. It occurs at locality PD-45 in the lower Concepcion "biozone", and at PD-35, in the Encanto "biozone".

Haplophragmoides species B
Plate 1, figure 2

Description.—Test free, large (1.0 mm), planispiral, evolute, biumbilicate, compressed; periphery rounded; chambers indistinct, seven to eight in the final whorl, increasing gradually in size, slightly inflated; sutures indistinct, radial, slightly depressed; wall very coarsely agglutinated with large (0.1–0.4 mm) irregular, poorly-sorted quartz fragments; aperture indistinct.

Discussion.—*Haplophragmoides* sp. B differs from *Haplophragmoides emaciatum* (Brady, 1884) in its more coarsely agglutinated wall.

Distribution.—*Haplophragmoides* sp. B is rare in the study area. It occurs only at localities PD-40 in the upper Concepcion "biozone", PD-54 in lower Concepcion "biozone", and PD-70 in Encanto "biozone".

Family **LOFTUSIIDAE** Brady, 1884

Subfamily **CYCLAMMININAE** Marie, 1941

Genus **CYCLAMMINA** Brady, 1879

Cyclammina cancellata Brady, 1879
Plate 1, figure 4

Cyclammina cancellata Brady, 1879, p. 62; Brady, 1884, pl. 37, figs. 8–16; LeRoy, 1944a, p. 14, pl. 4, figs. 44–45; Renz, 1948, p. 129, pl. 1, fig. 9; Phleger and Parker, 1951, p. 3, pl. 1, fig. 15; Matsunaga, 1963, pl. 24, figs. 13a–b; Akers and Dorman, 1964, p. 32, pl. 1, fig. 1; LeRoy and Hodgkinson, 1975, p. 432, pl. 4, figs. 15–17.

Description.—Test free, large, planispiral, biconvex, involute, with labyrinthic interior, periphery rounded, subcircular in side view; nine to ten chambers in the last whorl, slightly inflated, gradually increasing in size; sutures radial, slightly depressed; wall finely agglutinated, with a few larger quartz grains scattered throughout the test wall; aperture multiple, consisting of an equatorial interiomarginal slit and a series of rounded pores scattered over the apertural face.

Discussion.—All the individuals retrieved from the study area are abraded. The outer layer is absent, exposing the labyrinthic interior.

Distribution.—*Cyclammina cancellata* is reported from the Holocene of the Atlantic and Pacific; the Holocene and Pleistocene of the Gulf of Mexico; the Miocene of Japan, and Sumatra; and the Oligocene (Carapita Formation) of Venezuela. This species is rare in the lower Concepcion and Encanto "biozones" of the study area.

Family **TEXTULARIIDAE** Ehrenberg, 1838

Subfamily **SPIROPLECTAMMININAE** Cushman, 1927a

Genus **SPIROPLECTAMMINA** Cushman, 1927a

Spiroplectammina mississippiensis (Cushman, 1922)
Plate 1, figure 5

Textularia mississippiensis Cushman, 1922a, p. 90, pl. 14, fig. 4; Cushman, 1929a, p. 79, pl. 12, fig. 5.

Spiroplectammina mississippiensis (Cushman). Cushman and Renz, 1947, p. 4, pl. 1, fig. 5; Cushman and Stone, 1947, p. 3, pl. 1, fig. 7; Todd and Low, 1976, p. 24, pl. 1, fig. 4.

Description.—Test free, elongate, compressed, approximately twice as long as broad, rhomboid in transverse section, early portion a planispiral coil with later chambers biserially arranged; periphery irregular, acute; chambers distinct, slightly inflated, twice as broad as high, increasing gradually in size, three to four chambers in the early coiled portion, seven to ten pairs in the biserial portion; sutures distinct, oblique; wall finely perforate, finely agglutinated in contrast to the coarsely-agglutinated sutures; aperture a low arch at the base of the ultimate chamber.

Discussion.—*Spiroplectammina mississippiensis* differs from *S. caribbeana* Bermudez, 1949, from the Eocene of the Dominican Republic, in its fewer chambers, and narrower keel.

Distribution.—*Spiroplectammina mississippiensis* was described from the Byram Marl of Mississippi (Oligocene). It is also recorded from the Eocene of Peru, Oligo-Miocene of Puerto Rico, Tertiary of Venezuela and the early Miocene (St. Croix Formation) of Trinidad. This species is restricted to the Encanto "biozone" of the study area and occurs in low frequencies at most of the localities.

Genus **VULVULINA** d'Orbigny, 1826

Vulvulina miocenica Cushman, 1932
Plate 1, figure 6

Vulvulina spinosa Cushman var. *miocenica* Cushman, 1932a, p. 80, pl. 10, fig. 10; Cushman and Todd, 1945, p. 4, pl. 1, fig. 10; Cushman and Renz, 1947, p. 5, pl. 1, fig. 10; Renz, 1948, p. 179, pl. 2, fig. 1

Vulvulina spinosa miocenica Cushman. Coryell and Rivero, 1940, p. 325, pl. 41, fig. 1.

Description.—Test free, large (2.3 mm in length), compressed, rhomboid in transverse section, periphery acute, early portion coiled, later chambers biserially arranged, becoming uniserial; chambers indistinct and few in coiled portion; eight pairs in the biserial portion, depressed, broad and low, curved downward with a projecting spine at the outer margin; uniserial portion with four to five chambers, slightly inflated, broad and low, some possessing a projecting spine at outer margin; sutures raised, distinct in biserial portion, slightly depressed in the uniserial portion; wall agglutinated, smooth in biserial portion, uniserial portion with an irregular surface; aperture terminal, an elongate, narrow slit in plane of compression.

Discussion.—*Vulvulina spinosa* Cushman, 1927b, differs from *Vulvulina spinosa* Cushman var. *miocenica* Cushman, 1932a, in its depressed rather than raised sutures and inflated rather than depressed chambers in the biserial portion. *Vulvulina miocenica* is considered herein to be a distinct species. *Vulvulina jarvisi* Cushman, 1932a, differs from *V. miocenica* in its more strongly curved chambers in the biserial portion. *Vulvulina pennatula* (Batsch, 1791) differs from *V. miocenica* in its smooth, non-spinose periphery.

Distribution.—*Vulvulina miocenica* is recorded from the Tertiary of Haiti, early Miocene (St. Croix Formation) of Trinidad, late Miocene to early Pliocene (Bowden Formation) of Jamaica, early Miocene (San Lorenzo Formation) of Venezuela and the Oligo-Miocene (Sombrerito Formation) of the Dominican Republic. This species is rare at localities SD-4 and 12 in the Encanto "biozone".

Subfamily **TEXTULARIINAE** Ehrenberg, 1838

Genus **BIGENERINA** d'Orbigny, 1826

Bigenerina irregularis Phleger and Parker, 1951

Plate 1, figure 7

Bigenerina irregularis Phleger and Parker, 1951, p. 4, pl. 1, figs. 16–21; Bandy, 1954, p. 135, pl. 29, figs. 8–9; Andersen, 1961, p. 25, pl. 2, figs. 8a–b; Akers and Dorman, 1964, p. 23, pl. 1, fig. 15.

Description.—Test free, elongate, early portion biserial and compressed, becoming uniserial, axis of uniserial chambers set at an angle to the biserial portion which forms only one-third to one-fourth of the total length of test; seven to eight chambers in biserial portion, commonly obscured by agglutinated particles in the test wall; uniserial portion consisting of two to five inflated chambers with distinct sutures; wall perforate, coarsely agglutinated with diverse materials; aperture terminal, an irregular opening at end of a short neck.

Discussion.—The Pliocene specimens from the study area exhibit the same variations in shape, size, and texture as the Holocene forms described by Phleger and Parker (1951).

Distribution.—*Bigenerina irregularis* is reported from the Holocene and Pleistocene of the Gulf of Mexico and the Holocene of the Caribbean. It is common in the shallow water facies of the upper Concepcion "biozone".

Genus **TEXTULARIA** Defrance, *in* Blaineville, 1824

Textularia species A

Plate 1, figure 8

Description.—Test free, biserial, wedge-shaped in side and edge view, rhomboidal in transverse section, periphery angular, initial portion slightly compressed; seven to nine pairs of chambers in the adult, low and broad, increasing fairly rapidly in size as added, last few pairs slightly inflated, and have thickened upper margins; sutures straight to slightly curved, oblique; wall coarsely agglutinated, with a fairly smooth surface, except for the edges of the test which are rough and irregular, perforate; aperture a low broad opening in an indentation at the base of the inner margin of the ultimate chamber.

Discussion.—*Textularia nipeensis* Keijzer, 1945, is similar in form but has a more acute periphery and is much larger than *Textularia* sp. A.

Distribution.—*Textularia* sp. A is rare in the lower Concepcion and Encanto "biozones".

Textularia bermudezi Cushman and Todd, 1945

Plate 1, figure 9

Textularia flabelliformis Gumbel. Galloway and Morrey, 1929, p. 35, pl. 5, fig. 8 (not Gumbel, 1870).

Textularia bermudezi Cushman and Todd, 1945, p. 3, pl. 1, fig. 7; Todd and Low, 1976, p. 24, pl. 1, fig. 3.

Textularia leuzingeri Cushman and Renz. Bermudez, 1949, p. 62, pl. 2, figs. 39–40 (not Cushman and Renz, 1941).

Textularia granosuturata Becker and Dusenbury, 1958, p. 9, pl. 1, fig. 6.

Description.—Test free, biserial, compressed, slightly rhomboid in transverse section, periphery acute, length one-and-one-half times the width; chambers low and broad, depressed, nine to ten pairs in the adult, increasing gradually in size; sutures distinct and raised, strongly curved, each suture composed of coarsely arenaceous material; wall smooth, finely agglutinated, finely perforate; aperture a transverse slit in a slight indentation at the base of the final chamber.

Discussion.—*Textularia leuzingeri* Cushman and Renz, 1941, differs from *T. bermudezi* in its nearly straight sutures, rounded aperture and more inflated test.

Distribution.—*Textularia bermudezi* is found in the Neogene of Colombia, Oligo-Miocene of Puerto Rico, late Miocene to early Pliocene (Bowden Formation) of Jamaica, and middle Pliocene (Mao Formation) of the Dominican Republic. This species is rare in the upper and lower Concepcion "biozones" but is common at most localities in Encanto "biozone".

Textularia calva Lalicker, 1935
Plate 2, figure 1

Textularia calva Lalicker, 1935, p. 1, pl. 1, figs. 1–2; Lalicker and McCulloch, 1940, p. 120, pl. 13, fig. 6; Parker, 1958, p. 254, pl. 1, figs. 3–4; Andersen, 1961, p. 21, pl. 1, fig. 3.
Textularia canaensis Bermudez, 1949, p. 59, pl. 2, figs. 25–27.
Textularia candeiana d'Orbigny. Bermudez and Seiglie, 1963, p. 170, pl. 3, fig. 1 (not *T. candeiana* d'Orbigny, 1839a).

Description.—Test free, biserial, large (1.1 mm in length), triangular in side and edge views, ovate in transverse section, initial portion slightly compressed; eight pairs of chambers in the adult, initial chambers low and broad, increasing in size gradually, last three pairs inflated, increasing rapidly in size making up nearly one-half of the test; sutures indistinct, except in early portion, slightly depressed, straight, oblique; wall coarsely agglutinated, material poorly sorted, surface irregular, except on smooth apertural face; aperture a low, broad opening, in a deep indentation at the base of the inner margin of the final chamber.

Discussion.—*Textularia candeiana* d'Orbigny, 1839a, is similar to *T. calva* but differs in having a smooth exterior surface.

Distribution.—*Textularia calva* was described from the Holocene of the Gulf of Mexico. It is recorded from the Holocene of the Caribbean, Atlantic and Pacific oceans, and the Mediterranean Sea; Pleistocene of the Gulf Coast; and in the middle Pliocene (Mao Formation) of the Dominican Republic. This species is rare in the lower Concepcion and Encanto "biozones" of the study area.

Textularia lythostrota (Schwager, 1866)
Plate 2, figure 2

Plecanium lythostrota Schwager, 1866, p. 194, pl. 4, figs. 4a–c.
Textularia milletti Cushman, 1911, p. 13, text-figs. 18–19.
Textularia lythostrota (Schwager). Lalicker and McCulloch, 1940, p. 131, pl. 15, figs. 16a–c; Asano, 1950, p. 5, text-figs. 23, 24; LeRoy, 1964, p. 17, pl. 16, fig. 16.

Description.—Test free, compressed, biserial, somewhat longer than broad, subrhomboidal in side view, subrectangular in transverse section, periphery subacute; eight pairs of chambers in adult, low and broad, upper margin of each thickened so that the surface of the test is composed of an alternating series of raised ridges and depressions; sutures obscure, straight, oblique; wall coarsely agglutinated, with a rough surface, made up of poorly-sorted silt and clay, perforate; aperture a low, narrow opening in a deep indentation at the inner margin of the final chamber.

Discussion.—*Textularia lythostrota* differs from *T. calva* Lalicker, 1935, in its subrhomboidal outline in side view and its greater compression in transverse section.

Distribution.—*Textularia lythostrota* was described from the Pliocene of Car Nicobar. It is found in the Holocene of the Atlantic and Pacific, and the Pliocene of Okinawa and Japan. This species is rare in the upper and lower Concepcion and Encanto "biozones" of the study area.

Textularia mexicana Cushman, 1922
Plate 2, figure 3

Textularia mexicana Cushman, 1922b, p. 17, pl. 2, fig. 9; Hedberg, 1937, p. 666, pl. 90, fig. 4; Cushman and Todd, 1945, p. 1, pl. 1, fig. 1; Bermudez, 1949, p. 63, pl. 2, figs. 47, 48; Phleger and Parker, 1951, p. 5, pl. 2, figs. 6, 7; Akers and Dorman, 1964, p. 55, pl. 1, fig. 6; LeRoy and Levinson, 1974, p. 5, pl. 1, fig. 8.
Textularia warrenites Coryell and Rivero, 1940, p. 325, pl. 41, fig. 4.

Description.—Test free, biserial, compressed, about one-and-one-half times as long as broad; rhomboid in transverse section, test thickest near the middle, forming a longitudinal ridge; chambers numerous, approximately seven pairs of chambers, increasing gradually in breadth and height; wall smooth, finely agglutinated, sutures distinct, depressed toward outer margin; aperture a low arch at base of ultimate chamber.

Discussion.—*Textularia mexicana* differs from *Textularia* sp. A in its more rhomboid shape in transverse section and in the fewer chambers in the adult form.

Distribution.—*Textularia mexicana* is recorded from the Holocene of the Gulf of Mexico, Caribbean, and the Atlantic; Pleistocene of the Gulf of Mexico; Miocene of Haiti; Oligocene (Carapita Formation) of Venezuela; late Miocene to early Pliocene (Bowden Formation) of Jamaica; Miocene to Pliocene (Mao and Gurabo formations) of the Dominican Republic. This species is rare in the study area and occurs only at localities SD-4 and 12 in the Encanto "biozone".

Textularia sica Lalicker and Bermudez, 1941
Plate 2, figure 4

Textularia sica Lalicker and Bermudez, 1941, p. 16, pl. 4, figs. 5–6; Andersen, 1961, p. 23, pl. 1, figs. 5a–b; Akers and Dorman, 1964, p. 55, pl. 1, figs. 8–9.

Description.—Test free, compressed, biserial, elongate, rectangular in transverse section, peripheral margins flattened; five to eight pairs of chambers, low and broad, gradually increasing in height, slightly inflated; sutures distinct, depressed, straight, very oblique; wall coarsely agglutinated, surface roughened, perforate, material poorly sorted; aperture a narrow opening in a deep indentation at the inner margin of the final chamber.

Discussion.—*Textularia sica* differs from *Textularia lythostrota* (Schwager, 1866) in its smaller size, greater length-to-width ratio in side view, and its more rectangular shape in transverse section.

Distribution.—Textularia sica is recorded from the Holocene and Pleistocene of the Gulf of Mexico. It is rare at localities SD-29 and PD-66 in the shallow-water facies of the upper Concepcion "biozone" in the study area.

Subfamily **PSEUDOBOLIVINAE** Wiesner, 1931

Genus **SIPHOTEXTULARIA** Finlay, 1939

Siphotextularia affinis (Fornasini, 1883)

Plate 2, figure 5

Sagraina affinis Fornasini, 1883, p. 189, pl. 2, figs. 10a–c.
Karreriella affinis (Fornasini). Cushman, 1937a, p. 134, pl. 16, figs. 2–3; Colom, 1946a, p. 132, pl. 6, figs. 79–80; Dieci, 1959, p. 20, pl. 1, figs. 13a–b.
Siphotextularia miocenica Cushman and Todd, 1945, p. 4, pl. 1, fig. 9.
Siphotextularia catenata (Cushman). Bermudez, 1949, p. 66, pl. 2, figs. 23–24 (not *Textularia catenata* Cushman, 1911).
Siphotextularia affinis (Fornasini). Phleger and Parker, 1951, p. 4, pl. 1, fig. 22; Andersen, 1961, p. 24, pl. 2, fig. 5; Akers and Dorman, 1964, p. 54, pl. 1, fig. 13.
Siphotextularia masudai [?] Asano, 1953a, p. 17, pl. 1, figs. 8a–b.

Description.—Test free, biserial, slightly twisted on axis, one-and-one-half times as long as broad, periphery broadly rounded; seven to ten pairs of inflated chambers in the adult, early chambers low and broad, later becoming globular, increasing in size rapidly; sutures depressed, slightly oblique; wall smooth, finely agglutinated, fragile, finely perforate; aperture nearly terminal, in face of ultimate chamber, an elongate slit with a short neck, oriented parallel to compression of test.

Discussion.—Siphotextularia affinis differs from *S. curta* (Cushman, 1922b) in its thinner wall and in the orientation of the aperture, which is parallel, rather than perpendicular, to compression of the test.

Distribution.—Siphotextularia affinis was described from the Pliocene of Italy. It is recorded from the Holocene of the Gulf of Mexico and Atlantic Ocean; Pleistocene of the Gulf Coastal Plain; Miocene of Italy; the Miocene of Mallorca; and the late Miocene to early Pliocene (Bowden Formation) of Jamaica. This species is rare at localities PD-66 and 52 in the upper Concepcion and Encanto "biozones".

Siphotextularia concava (Karrer, 1868)

Plate 2, figure 6

Plecanium concavum Karrer, 1868, p. 129, pl. 1, fig. 3.
Textularia concava (Karrer). Cushman, 1911, p. 22, figs. 38a–b.
Siphotextularia concava (Karrer). Bermudez, 1949, p. 66, pl. 2, figs. 72–74; Barker, 1960, p. 86, pl. 42, figs. 13–14; LeRoy and Levinson, 1974, p. 5, pl. 1, figs. 11–12.

Description.—Test free, elongate, biserial, rectangular in transverse section with slightly concave sides, one-and-one-half times as long as broad; chambers broader than high, five to six pairs, increasing fairly rapidly in size; sutures straight, slightly raised in last few chambers; wall finely agglutinated, finely perforate; aperture a small slit surrounded by a distinct raised lip, near basal margin of ultimate chamber, perpendicular to the compression of test.

Discussion.—Siphotextularia concava is a distinctive species in the study area and can be differentiated from other species of *Siphotextularia* by its subrectangular cross-section and its concave sides.

Distribution.—This species is recorded from the Holocene of the Pacific; Pleistocene of the Gulf of Mexico; Neogene of the Vienna Basin and Romania; and the middle Pliocene (Mao Formation) of the Dominican Republic. *Siphotextularia concava* is rare at localities PD-35, 46, 52, and 68 in the Encanto "biozone" of the study area.

Siphotextularia curta (Cushman, 1922)

Plate 3, figure 1

Textularia flintii Cushman var. *curta* Cushman, 1922b, p. 14, pl. 2, figs. 2–3.
Textularia flintii Cushman. Bermudez, 1949, p. 61, pl. 2, figs. 11–12 (not Cushman, 1911).
Siphotextularia curta (Cushman). Phleger, Parker, and Pierson, 1953, p. 26, pl. 5, figs. 5–6; Parker, 1954, p. 491, pl. 2, fig. 15; Schnitker, 1971, p. 210, pl. 1, figs. 14a–b.

Description.—Test free, biserial, slightly longer than broad, periphery subrounded to rounded; chambers inflated, eight pairs of chambers in the adult, increasing fairly rapidly in size, earlier chambers low and broad, last pair highly inflated and globular; sutures depressed, oblique; wall agglutinated, smooth, finely perforate; aperture an elongate slit with a distinct neck, in the lower face of the ultimate chamber, oriented subperpendicular to the compression of test.

Discussion.—Siphotextularia curta differs from *S. flintii* (Cushman, 1911) in that its periphery is subrounded instead of quadrate, and it has a much shorter, broader test. *Siphotextularia curta* differs from *S. affinis* (Fornasini, 1883) in that its test wall is thicker and its aperture is oriented subperpendicular, rather than parallel, to the compression of test.

Distribution.—This species is found in the Holocene of the Atlantic and Gulf of Mexico. It is also recorded from the middle Pliocene (Mao Formation) of the Dominican Republic. *Siphotextularia curta* is rare at locality PD-68 in the Encanto "biozone".

Family **ATAXOPHRAGMIIDAE** Schwager, 1877

Subfamily **GLOBOTEXTULARIINAE**
Cushman, 1927a

Genus **ALVAREZINA** Bermudez and Rivero, 1963

Alvarezina sinuata Akers and Dorman, 1964
Plate 3, figure 2

Alvarezina cyclostomata sinuata Akers and Dorman, 1964, p. 21, pl. 2, figs. 1, 2.
Karreriella mexicana (Nuttall). Todd and Low, 1976 (part), p. 23, pl. 1, fig. 8 (not fig. 7) (not *Verneuilina mexicana* Nuttall, 1932).

Description.—Test free, elongate, circular in cross-section, early stage trochoid (four to five chambers per whorl) then reducing to three chambers in final whorl; chambers increasing gradually in size in the trochoid portion, rapidly increasing in size in the triserial portion and highly inflated; sutures distinct, slightly depressed in triserial portion; wall smooth, finely agglutinated, finely perforate; aperture located in a depression in face of the ultimate chamber, a sinuate, elongate slit bordered by a distinct lip.

Discussion.—*Alvarezina* Bermudez and Rivero, 1963 [type-species *A. mexicana* (Nuttall, 1932)] was erected to include forms that are similar to *Karreriella* Cushman, 1933a, but which are triserial, rather than biserial, in the later whorls.

Akers and Dorman (1964, p. 21) considered *Alvarezina mexicana* (Nuttall, 1932) as either a synonym or subspecies of *A. cyclostomata* (Galloway and Morrey, 1929).

After reviewing the type descriptions and topotypes of both species, *A. cyclostomata sinuata* is elevated to a species level herein because of the greater size of the test and the sigmoidal development of the aperture.

Distribution.—*Alvarezina sinuata* was described from the Pleistocene of the Gulf of Mexico. It is also recorded from the Oligocene in a well in Puerto Rico. This species is rare in the lower Concepcion and Encanto "biozones".

Genus **EGGERELLA** Cushman, 1933a

Eggerella bradyi (Cushman, 1911)
Plate 3, figure 3

Verneuilina bradyi Cushman, 1911, p. 54, text-figs. 87a–b.
Eggerella bradyi (Cushman). Cushman, 1937a, p. 52, pl. 5, fig. 19; Colom, 1946a, p. 61, pl. 4, figs. 120–121; Phleger and Parker, 1951, p. 6, pl. 3, figs. 1, 2; Barker, 1960, p. 96, pl. 47, figs. 4–7; LeRoy, 1964, p. 18, pl. 1, figs. 13–14; LeRoy and Hodgkinson, 1975, p. 434, pl. 6, fig. 4.

Description.—Test free, conical, early stage a trochospiral coil reducing to triserial in the adult; chambers inflated, increasing rapidly in size so that the last whorl forms more than one-half the test; wall smooth, finely agglutinated, finely perforate; sutures distinct, slightly depressed; aperture a low, thin slit at the base of the ultimate chamber.

Distribution.—*Eggerella bradyi* has been recorded from the Holocene of the Atlantic and Pacific oceans, the Gulf of Mexico and the Mediterranean Sea; Pliocene of Okinawa and Fiji; and Miocene of Mallorca. This species is found only in the Encanto "biozone" of the study area.

Genus **KARRERIELLA** Cushman, 1933d

Karreriella bradyi (Cushman, 1911)
Plate 3, figures 4–5

Gaudryina bradyi Cushman, 1911, p. 67, text-figs. 107a–c.
Karreriella bradyi (Cushman). Cushman, 1937a, p. 135, pl. 16, figs. 6–11; Cushman and Todd, 1945, p. 8, pl. 1, fig. 20; Colom, 1946b, p. 61, pl. 4, figs. 112–114; Bermudez, 1949, p. 89, pl. 5, figs. 11–16; LeRoy, 1964, p. 18, pl. 1, figs. 22, 23; Murray, 1971, p. 47, pl. 16, figs. 1–4.

Description.—Test free, elongate, early chambers in trochoid spire, followed by a well-developed twisted biserial stage of four to five pairs of chambers, rounded in transverse section; chambers inflated, overlapping, gradually increasing in size; wall finely agglutinated, smooth, finely perforate; sutures distinct in biserial portion and depressed, less distinct in trochoid portion; aperture areal, an elongate opening with a distinct raised lip in terminal face of ultimate chamber, parallel to suture.

Discussion.—*Karreriella subcylindrica caribaea* Acosta, 1940, differs from *K. bradyi* in possessing a more twisted biserial stage comprising four-fifths of the test and having more globular chambers.

Distribution.—*Karreriella bradyi* has been recorded from the Holocene of the Atlantic and Pacific oceans, Caribbean and Gulf of Mexico; Neogene of Okinawa, Venezuela, and Mallorca; and the late Miocene to early Pliocene (Gurabo Formation) of the Dominican Republic. This species is restricted to the Encanto "biozone" occurring at localities PD-58, 68, 72, and 77.

Karreriella subcylindrica caribaea Acosta, 1940
Plate 3, figure 6

Karreriella subcylindrica (Nuttall) var. *caribaea* Acosta, 1940, p. 3, pl. 1, figs. 1–3; Cushman, 1947a, p. 44, pl. 7, figs. 24–26.

Description.—Test free, elongate, cylindrical, circular in transverse section, four times as long as broad, early trochoid spire one-fifth the length of test, the remainder twisted biserial; chambers in the early trochoid portion indistinct, four to five pairs in the biserial portion, inflated, twisted about the axis; sutures indistinct in trochoid portion, distinct and depressed in biserial portion; wall finely agglutinated, smooth, finely perforate; aperture terminal, an elongate slit bordered by a lip in face of ultimate chamber.

Discussion.—This subspecies differs from *Karreriella subcylindrica* (Nuttall, 1928), in having a more elongate test and greater number of chambers in the biserial portion. It differs from *K. bradyi* (Cushman, 1911) in having a more twisted axis and more globular chambers.

Distribution.—This subspecies has been recorded only from the Holocene of the Gulf of Mexico. It occurs only at locality PD-70 in the Encanto "biozone".

Subfamily **VERNEUILININAE** Cushman, 1911

Genus **GAUDRYINA** d'Orbigny, *in* Sagra, 1839

Gaudryina atlantica (Bailey, 1851)

Plate 3, figure 7

Textularia atlantica Bailey, 1851, p. 12, text-figs. 38–43.

Gaudryina atlantica (Bailey). Cushman, 1922b, p. 70, pl. 13, figs. 1–3; Bermudez, 1949, p. 74, pl. 3, figs. 63, 64.

Gaudryina (*Pseudogaudryina*) *atlantica* (Bailey). Cushman, 1937b, p. 95, pl. 14, figs. 4, 5; Galloway and Heminway, 1941, p. 325, pl. 7, fig. 3; Cushman and Todd, 1945, p. 4, pl. 1, fig. 11; Phleger and Parker, 1951, p. 6, pl. 2, figs. 13a–b.

Description.—Test free, large (1.9 mm in length), length twice the width, early stage triserial, short, triangular in transverse section, later portion biserial, generally triangular in transverse section, with three longitudinal carinae; chambers indistinct in triserial portion, distinct in biserial portion, four to five pairs in the adult, slightly inflated; sutures indistinct in triserial portion, distinct and slightly depressed in biserial portion; wall smooth, coarsely agglutinated; aperture an elongate opening located in an indentation at the base of the ultimate chamber.

Discussion.—*Gaudryina atlantica* differs from *G. jacksonensis* Cushman, 1926a, in its less strongly-developed carinae and fewer chambers.

Distribution.—*Gaudryina atlantica* was originally described from the Holocene of the Atlantic Ocean. It is recorded from the Holocene and Pleistocene of the Gulf of Mexico, and the Caribbean; late Miocene to early Pliocene (Bowden Formation) of Jamaica; early Miocene (Ponce Formation) of Puerto Rico; and the middle Pliocene (Mao Formation) of the Dominican Republic. It is rare in the lower Concepcion and Encanto "biozones".

Subfamily **VALVULININAE** Berthelin, 1880

Genus **CLAVULINA** d'Orbigny, 1826

Clavulina mexicana Cushman, 1922

Plate 4, figure 1

Clavulina humilis Brady var. *mexicana* Cushman, 1922b, p. 83, pl. 16, figs. 1–3.

Pseudoclavulina mexicana (Cushman). Cushman, 1937b, p. 117, pl. 16, figs. 5–11; Cushman and Todd, 1945, p. 5, pl. 1, fig. 14; Bermudez, 1949, p. 73, pl. 3, figs. 41–44; Phleger and Parker, 1951, p. 6, pl. 2, figs. 14–16; Andersen, 1961, p. 27, pl. 2, fig. 12.

Clavulina yabei [?] Asano, 1936a, p. 612, pl. 30, figs. 2–4.

Description.—Test free, elongate, length four times the width, early portion sharply triangular in section with chambers triserially arranged, later uniserial portion circular in section, uniserial portion two to three times the length of triserial portion; chambers indistinct in triserial portion, distinct in uniserial portion, four to five chambers, slightly inflated; sutures indistinct in triserial portion, distinct, depressed and horizontal in uniserial portion; wall coarsely agglutinated, finely perforate; aperture terminal, rounded to irregular in shape, at end of short neck.

Distribution.—*Clavulina mexicana* was described from the Holocene of the Gulf of Mexico. It is recorded from the Holocene of the Atlantic and Caribbean, the Pleistocene of the Gulf of Mexico, the late Miocene to early Pliocene (Bowden Formation) of Jamaica, and the late Miocene to early Pliocene (Gurabo Formation) of the Dominican Republic. This species is common in the Concepcion and Encanto "biozones" at most localities.

Genus **MARTINOTTIELLA** Cushman, 1933a

Martinottiella communis (d'Orbigny, 1846)

Plate 4, figure 2

Clavulina communis d'Orbigny, 1846, p. 196, pl. 12, figs. 1–2; Kleinpell, 1938, p. 193, pl. 3, fig. 4.

Listerella communis (d'Orbigny). Cushman, 1937a, p. 148, pl. 17, figs. 4–9; Colom, 1946a, p. 132, pl. 4, figs. 32, 43.

Martinottiella communis (d'Orbigny). Asano, 1950, p. 3, figs. 16, 17; Agip Mineraria, 1957, pl. 5, fig. 6.

Schenckiella communis (d'Orbigny), LeRoy, 1964, p. 17, pl. 1, fig. 17.

Martinottiella occidentalis (Cushman). LeRoy and Levinson, 1974, p. 6, pl. 1, fig. 18 (not *Clavulina occidentalis* Cushman, 1922b).

Description.—Test free, elongate, circular in transverse section, length five times the width, early chambers trochospiral reduced to triserial and later to uniserial, initial portion broadly rounded; chambers indistinct in early portion, distinct in the uniserial portion, seven to eight chambers, increasing gradually in size, slightly inflated, early portion broader than the first few chambers of uniserial portion; sutures slightly depressed in uniserial part, horizontal; wall smooth, finely agglutinated, finely perforate; aperture terminal, a small round opening at center of ultimate chamber.

Discussion.—Well-preserved specimens have a short neck (Poag, written commun., 1982).

Distribution.—The type locality for *Martinottiella communis* (d'Orbigny) was not designated. It has been recorded from the Holocene of the Atlantic Ocean and Mediterranean Sea, Pleistocene of the Gulf of Mexico, Pliocene of Japan and Okinawa, Miocene of Mallorca, and Miocene of California. This species is rare in the Encanto "biozone" at localities PD-35, 68, and 72.

Family **TEXTULARIELLIDAE** Grönhagen and Luterbacher, 1966

Genus **TEXTULARIELLA** Cushman, 1927a

Textulariella barrettii (Jones and Parker, 1876)

Plate 4, figure 3

Textularia barrettii Jones and Parker, 1876, p. 99, text-figs.
Textularia pseudotrochus Cushman, 1922b, p. 21, pl. 5, figs. 1–3.
Textulariella barrettii (Jones and Parker). Cushman, 1937a, p. 66, pl. 7, figs. 5–8; Cushman and Todd, 1945, p. 6, pl. 1, fig. 16; Bermudez, 1949, p. 80, pl. 4, figs. 19–20; Andersen, 1961, p. 28, pl. 3, figs. 4a–b; Akers and Dorman, 1964, p. 56, pl. 1, figs. 26–27.

Description.—Test free, subconical, early stage trochospiral, later biserial, with labyrinthic interior, circular in transverse section; chambers indistinct in the early trochospiral portion, later biserial portion with five to ten pairs, increasing fairly rapidly in size, chambers divided by partitions that extend inward from the periphery; sutures indistinct, perpendicular to axis of growth; wall finely agglutinated, with a smooth exterior, finely perforate; aperture a low interiomarginal arch, at the base of the ultimate chamber.

Discussion.—The individuals occurring in the study area are smaller than those figured in the above references.

Distribution.—*Textulariella barrettii* was described from the Holocene of Jamaica. It is found in the Holocene of the Atlantic and the Caribbean, Holocene and Pleistocene of the Gulf of Mexico, late Miocene to early Pliocene (Bowden Formation) of Jamaica, middle Pliocene (Mao Formation) of the Dominican Republic, early Miocene (San Lorenzo Formation) of Venezuela, and early Miocene (St. Croix Formation) of Trinidad. This species is rare in the Encanto "biozone" at locality SD-4.

Suborder **MILIOLINA** Delage and Hérouard, 1896

Superfamily **MILIOLACEA** Ehrenberg, 1839

Family **NUBECULARIIDAE** Jones, 1875

Subfamily **SPIROLOCULININAE** Wiesner, 1920

Genus **SPIROLOCULINA** d'Orbigny, 1826

Spiroloculina alveata Cushman and Todd, 1944

Plate 4, figure 4

Spiroloculina depressa d'Orbigny. Cushman and Cahill, 1933, p. 10, pl. 2, figs. 7a–b (not d'Orbigny, 1826).
Spiroloculina alveata Cushman and Todd, 1944, p. 28, pl. 4, figs. 29–30; Cushman and Stainforth, 1945, p. 20, pl. 2, figs. 15–17; Cushman and Todd, 1945, p. 10, pl. 2, fig. 2; Todd and Low, 1976, p. 24, pl. 1, fig. 16.

Description.—Test free, elongate to circular in side view, biumbilicate, rectangular in transverse section, greatest width near midpoint; chambers distinct, 11–12 in the adult, quadrangular in section, gradually increasing in size, the outer carinate margins distinctly raised above the surface of the previous chambers producing an excavated or channelled appearance; sutures distinct, depressed; wall smooth, porcellaneous; aperture terminal, slightly produced, an elongate opening with a short simple tooth at the inner margin.

Discussion.—*Spiroloculina alveata* differs from *S. depressa* d'Orbigny, 1826, in not possessing depressed sutures and in having raised carinate chamber margins.

Distribution.—This species was described from late Miocene to early Pliocene (Bowden Formation) of Jamaica. It is also recorded from the Oligo-Miocene (Cipero Formation) of Trinidad, Miocene (Choctawhatchee Formation) of Florida, and an Oligo-Miocene well in Puerto Rico. *Spiroloculina alveata* is rare in the upper and lower Concepcion "biozones" and the Encanto "biozone".

Spiroloculina? disparilis Terquem, 1878

Plate 4, figures 5–7

Spiroloculina disparilis Terquem, 1878, p. 55, pl. 5, figs. 12a–c.

Description.—Test free, fusiform, small (length 0.5 mm), concavoconvex in transverse section, elongate, two-and-one-half times as long as broad; chambers distinct, inflated, quadrate in cross-section, 13 to 14 in the adult, added two to a whorl on alternate sides not in a single plane; chambers increasing rapidly in size, expanding outward from the proloculus to form a furrow or trough on one side of test; chamber margins angular, forming a raised rim on the last few chambers on the concave side, convex side smooth; sutures indistinct, obscured by overlapping of successive chambers; wall smooth, thin, porcellaneous; aperture terminal, circular, on slight neck.

Discussion.—Cushman and Todd (1944) place *Spiroloculina affixa* Terquem, 1878, in synonymy with *S. disparilis.* There is a difference sufficient to support separation. *Spiroloculina disparilis* has more chambers, is concavoconvex instead of planoconcave, and is a thinner-walled form than *S. affixa.*

Loeblich and Tappan (1964a, p. C453), state that *Spiroloculina* d'Orbigny, 1826, must have chambers added in a single plane. *Spiroloculina disparilis* Terquem, 1878, however, has a concavoconvex cross-section as do specimens here assigned to *S.*? *disparilis* (Pl. 4, fig. 7). Therefore, *S.*? *disparilis* is placed provisionally herein in the genus *Spiroloculina* until additional studies can confirm whether *Spiroloculina* should be amended to include those forms that do not have chambers in a single plane.

Distribution.—*Spiroloculina disparilis* was described from the late Pliocene of the Isle of Rhodes. *S.*? *disparilis* is rare in the upper and lower Concepcion "biozones" at localities PD-40, 45 and 54.

Subfamily **OPHTHALMIDIINAE** Wiesner, 1920

Genus **OPHTHALMIDIUM**
Kübler and Zwingli, 1870

Ophthalmidium species A
Plate 4, figures 8–10

Description.—Test free, planispiral, all chambers visible, flat, periphery bluntly rounded, fusiform in side view, length almost twice the width, widest near middle of test; ovate proloculus, followed by a tubular chamber in the plane of symmetry narrowing gradually to its terminus, the third chamber arising abruptly from the preceding one, one-half coil in length, widest at its initial end and decreasing in size to the junction of next chamber; all subsequent chambers one-half coil in length and regularly added to form 12 to 14 chambers in the adult; sutures indistinct, chambers separated by a flattened plate equal to the width of the chambers; wall smooth, porcellaneous; aperture rounded, at end of ultimate chamber.

Discussion.—*Ophthalmidium* sp. A is similar to *Ophthalmidium minima* Tappan, 1943, from the Early Cretaceous of Oklahoma but differs in the less uniform shape of the chambers. *Ophthalmidium acutimargo* (Brady, 1884) differs from *Ophthalmidium* sp. A in possessing an acute periphery and fewer chambers.

Distribution.—*Ophthalmidium* sp. A is rare in the Encanto "biozone" at localities PD-38 and 70.

Family **MILIOLIDAE** Ehrenberg, 1839

Subfamily **QUINQUELOCULININAE**
Cushman, 1917

Genus **PYRGO** Defrance, *in* Blaineville, 1824

Pyrgo murrhina (Schwager, 1866)
Plate 5, figure 1

Biloculina murrhina Schwager, 1866, p. 203, pl. 4, figs. 15a–c.
Biloculina bradyi Fornasini, 1886, p. 261 (after Brady, 1884, pl. 2, figs. 15a–b).
Pyrgo murrhina (Schwager). Cushman, 1929b, pl. 19, figs. 6a–b (after Brady, 1884); Phleger and Parker, 1951, p. 7, pl. 3, fig. 11; LeRoy and Levinson, 1974, p. 6, pl. 2, fig. 5.
Pyrgo aff. *murrhina* (Schwager). LeRoy, 1941c, p. 113, pl. 3, figs. 29–30.

Description.—Test free, inflated, subcircular in side view, subovate in transverse section with margin extended and carinate; chambers biloculine in adult, inflated, penultimate chamber with a weak carina parallel to the keel of the ultimate chamber; ornamented by a broad keel that extends completely about the periphery, but possessing a small sinus at posterior end; wall smooth, porcellaneous; aperture terminal, near junction of last two chambers, with a prominent tubular neck and a bifid tooth partially filling the opening.

Discussion.—*Pyrgo depressa* (d'Orbigny, 1826) differs from *P. murrhina* in possessing a very narrow elongate aperture; the aperture of *P. murrhina* has a prominent tubular neck and a bifid tooth.

Distribution.—*Pyrgo murrhina* is recorded from the Holocene of the Atlantic, Pacific, Gulf of Mexico, and Caribbean; Pleistocene of the Gulf Coast; Pliocene of Car Nicobar, Japan, and Italy. It is also found in the Tertiary of Haiti, late Miocene to early Pliocene (Bowden Formation) of Jamaica, and the Oligo-Miocene (Cipero Formation) of Trinidad. This species is rare in the lower Concepcion and Encanto "biozones".

Pyrgo phlegeri Andersen, 1961
Plate 5, figure 2

Pyrgo phlegeri Andersen, 1961, p. 38, pl. 8, figs. 1a–c, 2a–c.

Description.—Test free, inflated, subcircular in side view, ovate in transverse section, with margin extended and carinate; chambers biloculine in adult, inflated, penultimate chamber with a weak carina parallel to the prominent carina on the ultimate chamber; wall smooth, porcellaneous; aperture terminal, a narrow crescent-shaped slit, with a simple tooth, near junction of last two chambers.

Discussion.—*Pyrgo murrhina* (Schwager, 1866) differs from *P. phlegeri* in its more strongly-developed keel and a more circular outline in side view.

Distribution.—*Pyrgo phlegeri* was described from the "mudlumps" of the Mississippi River Delta, which are Pleistocene to Holocene in age. It is rare in the Concepcion and Encanto "biozones".

Genus **SIGMOILINITA** Seiglie, 1965

Sigmoilinita distorta (Phleger and Parker, 1951)
Plate 5, figure 3

Sigmoilina distorta Phleger and Parker, 1951, p. 8, pl. 4, figs. 3–5; Parker, 1954, p. 499, pl. 4, figs. 17, 21; Parker, 1958, p. 256, pl. 1, fig. 25; Andersen, 1961, p. 34, pl. 7, figs. 8a–b; Todd and Low, 1967, p. 19, pl. 2, fig. 18.

Description.—Test free, small, compressed, length twice the breadth; early chambers quinqueloculine, later biloculine, added in planes slightly more than 180° from one another, forming a sigmoidal curve in transverse section; chambers distinct, inflated, two in a coil making a deep bend toward central part of test producing a twisted appearance in edge view, four to five pairs of chambers visible in adult; sutures distinct, depressed, wall smooth, calcareous; aperture terminal, a circular opening, at the end of a projection of the final chamber.

Discussion.—Seiglie (1965, p. 72) erected the genus *Sigmoilinita* for species of *Sigmoilina* in which the chambers of the later biloculine stage were visible from the exterior; *i.e.,* "the wall of each chamber does not cover any of the preceding ones". *Sigmoilinita distorta* can be distinguished from other species of *Sigmoilinita* by its twisted appearance in edge view. The bending of the last few chambers is characteristic of *S. distorta.*

Distribution.—This species was described from the Holocene of the Gulf of Mexico. It is recorded from the Holocene of the Atlantic, Gulf of Alaska, and the Mediterranean Sea; and the Pleistocene of the Gulf of Mexico. *Sigmoilinita distorta* is rare and restricted to the Encanto "biozone".

Sigmoilinita elliptica (Galloway and Wissler, 1927)

Plate 5, figure 4

Sigmoilina tenuis (Czjzek). Cushman, 1918a, p. 81, pl. 31, figs. 4a–c (not *Quinqueloculina tenuis* Czjzek, 1848); Cushman, 1930, p. 22, pl. 2, figs. 8a–c (not Czjzek, 1848).

Sigmoilina elliptica Galloway and Wissler, 1927, p. 39, pl. 7, figs. 2a–b.

Sigmoilina tschokrakensis Gherke forma *compressa* [?] Gherke, 1938, p. 312, pl. 3, figs. 4, 13, 18.

Sigmoilina miocenica Cushman, 1946, p. 33, pl. 5, figs. 19–22.

Description.—Test free, moderately compressed, ovate in outline, periphery rounded, length one-and-one-half to twice the breadth; chambers in early stage quinqueloculine, biloculine in later stage added in a plane greater than 180° from one another, forming sigmoidal curve in transverse section; chambers distinct, inflated, tubular, increasing rapidly in size as added, scarcely overlapping, four pairs of chambers visible in adult; sutures slightly depressed, indistinct; wall smooth, calcareous; aperture terminal, round, at end of slight projection of ultimate chamber.

Discussion.—This species differs from *Sigmoilinita tenuis* (Czjzek, 1848) in its more sigmoid chamber arrangement, more inflated chambers, less distinct sutures, and less compressed test.

Distribution.—Sigmoilinita elliptica was described from the Pleistocene of the Lomita Marl of southern California. This species is rare in the Concepcion and Encanto "biozones".

Sigmoilinita tenuis (Czjzek, 1848)

Plate 5, figure 5

Quinqueloculina tenuis Czjzek, 1848, p. 149, pl. 13, figs. 31–34.

Spiroloculina tenuissima Reuss, 1867, p. 71, pl. 1, fig. 11.

Spiroloculina berchtoldsdorfensis [?] Karrer, 1877, p. 375, pl. 16a, fig. 10.

Sigmoilina tenuis (Czjzek). Cushman and Todd, 1945, p. 10, pl. 2, fig. 4; Cushman and Gray, 1946, p. 5, pl. 1, figs. 14–16; Marks, 1951, p. 39, pl. 5, fig. 7; Phleger and Parker, 1951, p. 8, pl. 4, fig. 7; Todd and Brönnimann, 1957, p. 29, pl. 4, fig. 3; Parker, 1958, p. 257, pl. 1, fig. 24; LeRoy, 1964, p. 20, pl. 16, figs. 32, 33.

Description.—Test free, compressed, small, ovate in outline, periphery rounded, length one-and-one-half times the breadth, quinqueloculine in the initial portion with later biloculine chambers added at slightly more than 180° from one another, forming a sigmoidal curve in transverse section; chambers distinct, inflated, embracing, narrow, elongate, four to five pairs visible in the adult; sutures distinct, depressed; wall smooth, calcareous; aperture terminal, circular, at end of slight projection of final chamber.

Discussion.—Seiglie (1965, p. 72) selected *Sigmoilinita tenuis* (Czjzek) as the type species of *Sigmoilinita.* The highly compressed forms with weakly sigmoidal chamber arrangement are regarded here as typical of *S. tenuis.* Cushman (1930, p. 22) includes forms that are highly sigmoidal and highly inflated. Marks (1951, p. 29) is more restrictive in his synonymy, including only compressed forms.

Distribution.—Sigmoilinita tenuis (Czjzek) was described from the Tertiary of Austria. It is also recorded from the Holocene of the Gulf of Mexico, the Caribbean, and the Mediterranean; the Pliocene of California, and Okinawa; the Tertiary of Poland; and the late Miocene to early Pliocene (Bowden Formation) of Jamaica. This species is rare in the Concepcion and Encanto "biozones".

Genus **SIGMOILOPSIS** Finlay, 1947

Sigmoilopsis schlumbergeri (Silvestri, 1904)

Plate 5, figure 6

Sigmoilina schlumbergeri Silvestri, 1904, p. 267, pl. 7, figs. 12–14, p. 481, text-fig. 6, p. 482, text-fig. 7; Cushman and Todd, 1945, p. 11, pl. 2, fig. 3; Bermudez, 1949, p. 107, pl. 6, figs. 21, 22; Asano, 1951, p. 11, text-figs. 75, 76.

Sigmoilopsis schlumbergeri (Silvestri). Barker, 1960, p. 16, pl. 8, figs. 1–4; Andersen, 1961, p. 34, pl. 7, figs. 7a–b; Akers and Dorman, 1964, p. 53, pl. 11, figs. 16–18.

Description.—Test free, ovate in side view, length one-and-one-half times the width, subtriangular in transverse section; chambers indistinct, inflated, two to a coil added in planes slightly greater than 180° from one another, forming a sigmoidal curve seen in transverse section; sutures indistinct; wall finely agglutinated over most of the test except for the outer margin of the last two chambers, which is smooth; aperture terminal, rounded, with a bifid tooth, surrounded by an imperforate lip.

Distribution.—Sigmoilopsis schlumbergeri was described from the Holocene of the Atlantic. It is recorded from the Holocene of the Mediterranean, and Gulf of Mexico; Pleistocene of the Gulf of Mexico; Pliocene of Japan, Okinawa, and Italy; late Miocene to early Pliocene (Bowden Formation) of Jamaica; middle Pliocene (Mao Formation) of the Dominican

Republic; Oligo-Miocene (Cipero Formation) of Trinidad; middle to late Miocene (Cojimar Formation) of Cuba. It is rare in the upper Conception "biozone", common in the lower Concepcion "biozone", and common to abundant in the Encanto "biozone".

Suborder **ROTALIINA** Delage and Hérouard, 1896

Superfamily **NODOSARIACEA** Ehrenberg, 1838

Family **NODOSARIIDAE** Ehrenberg, 1838

Subfamily **NODOSARIINAE** Ehrenberg, 1838

Genus **AMPHICORYNA** Schlumberger, *in* Milne-Edwards, 1881

Amphicoryna sublineata (Brady, 1884)

Plate 6, figures 10–13

Nodosaria hispida d'Orbigny var. *sublineata* Brady, 1884, p. 508, pl. 63, figs. 19–22.

Nodosaria sublineata Brady. Cushman, 1923, p. 88, pl. 17, fig. 1; Boltovskoy, 1959, p. 65, pl. 8, fig. 5.

Lagenonodosaria sublineata (Brady). Agip Mineraria, 1957, pl. 19, fig. 9.

Nodosaria hispida d'Orbigny. Akers and Dorman, 1964, p. 46, pl. 5, fig. 31 (not *N. hispida* d'Orbigny, 1846).

Amphicoryna? *sublineata* (Brady). LeRoy and Levinson, 1974, p. 7, pl. 3, fig. 9.

Description.—Test free, uniserial, elongate, slender, circular in cross-section; initial end rounded with a short spine; chambers inflated, subspherical, four to six arranged in a rectilinear series in the megalospheric form, joined by a short thick neck; early chambers closely set, later chambers separated by a short neck, increasing rapidly in size as added; sutures flush and horizontal in megalospheric form, oblique in the microspheric form; wall calcareous, hyaline, finely perforate, ornamented by short intermittent costae and spines arranged in longitudinal rows, more pronounced on the first few chambers, changing to lineations of spines on the ultimate chamber; aperture terminal, a round opening surrounded by a phialine lip with radiating projections, at the end of a long neck that is ornamented by transverse rings and spines.

Discussion.—Megalospheric forms are dominant in the Mexican samples with only rare microspheric specimens found (see Pl. 6, fig. 13). Within a population of *A. sublineata,* some forms are smooth with only remnants of costae and spines. Since these less ornate individuals are common and are identical in shape, size and number of chambers, they are considered in this study to be phenotypic variations of the more ornate types that are shown in Plate 6, figures 10–12.

Amphicoryna hispida (d'Orbigny, 1846), differs from *A. sublineata* in lacking the short costae and lineations of the spines.

Distribution.—This species was described from the Holocene of the north Atlantic Ocean. It has also been recorded from the Holocene and Pleistocene of the Gulf of Mexico and the Neogene of Italy. *Amphicoryna sublineata* is common in the Concepcion and Encanto "biozones".

Genus **CHRYSALOGONIUM** Schubert, 1907

Chrysalogonium glabrum (Silvestri, 1896)

Plate 7, figure 2

Nodosaria subtertenuata Schwager var. *glabra* Silvestri, 1896, p. 150, pl. 3, figs. 22–23.

Description.—Test free, uniserial, elongate, circular in transverse section, initial end rounded, often with a short spine; chambers subspherical in early portion, later becoming longer than broad, five in the adult, inflated; sutures distinct, nearly flush in early portion, strongly depressed in the later portion; wall calcareous, hyaline, smooth, finely perforate; aperture terminal, cribrate, at end of a distinct neck, consisting of a central polygonal opening surrounded by five to six subrectangular openings, outer perimeter bordered by a phialine lip.

Discussion.—The neck of *C. glabrum* appears to consist of a bundle of five to six open-ended tubes (see Pl. 7, figs. 2c–d).

Chrysalogonium elongatum Cushman and Jarvis, 1934, is similar to *C. glabrum* but lacks the distinct neck and phialine lip.

Distribution.—*Chrysalogonium glabrum* was described from the early Pliocene of Italy. It is rare in the lower Concepcion and Encanto "biozones".

Chrysalogonium spinastelliferum, new species

Plate 7, figure 1; Plate 37, figure 1

Etymology of name.—L. *spina* = spine, + *L. stellifer* = star-bearing (in reference to the starlike termination of the spines).

Description.—Test free, small, uniserial, initial end rounded, circular in transverse section; chambers few, two to four in the adult, inflated, subspherical, similar in size throughout, first two closely set, third and fourth chambers separated by a distinct neck; sutures distinct, perpendicular to axis of growth; wall calcareous, finely perforate, ornamented by small spines; aperture at the end of a long neck equal in length to the height of ultimate chamber, cribrate with 14 to 15 circular openings in plate that is elevated above the rim of the neck.

Diagnosis.—*Chrysalogonium* with two to four equal-sized chambers with very finely hispid ornamentation.

Discussion.—The spinose ornamentation on this species is unusual. The ultimate chamber has single spines that terminate in a symmetrical triradiate process (Pl. 37, figs. 1b, 1c, 1d). The penultimate chamber has a more complex arrangement of triradiating spines that interlock to form a netlike covering on the chamber (see Pl. 37, figs. 1e, 1f).

C. spinastelliferum is similar in form to *Nodosaria aspera* Silvestri, 1872, from the Pliocene of Italy. However, Silvestri did not describe the details of the aperture of that form. It appears from Silvestri's type figures that the aperture has the characteristics of the genus *Amphicoryna* Schlumberger, 1881, and probably is not referable to *Chrysalogonium.* As neither the type locality nor depository was designated, further investigation is unlikely (*fide* Ellis and Messina, 1940).

Types.—Holotype: USNM 400649; paratypes: USNM 400650.

Measurements.—Mean for three three-chambered forms: length 0.8 mm, width 0.2 mm.

Type locality.—Locality PD-35, Potrerillos Dome, south side of Mexican Highway #180, 16 km east of Acayucan, state of Veracruz, Mexico.

Other localities.—Rare at most sites in the Encanto "biozone" (N.19) in the study area.

Genus **CRIBROLENTICULINA** Haman, 1978

Cribrolenticulina akersi Haman, 1978
Plate 7, figure 9

Cribrolenticulina akersi Haman, 1978, no. 2, p. 90, pl. 1, figs. A–X, pl. 2, figs. A–S, pl. 3, figs. A–N, pl. 4, figs. A–S.

Description.—Test free, planispiral, initial portion closely coiled and compressed, later portion tending to uncoil, distinct keel in early portion with acute periphery in later portion, ovate in transverse section; chambers distinct, eight to 12 in the adult, increasing gradually in size as added, apertural face long and narrow; sutures ornamented, beaded in the early portion, becoming less developed on the later portion with some elongate projections oriented parallel to the axis of coiling; wall calcareous, hyaline, finely perforate, smooth except for beaded sutures; aperture terminal, cribrate, a network of ten to 30 subcircular openings in the center of the apertural plate, bordered by 18 to 20 elongate openings.

Discussion.—The complex apertural arrangement of openings seen in Plate 7, figure 9d may be formed, as suggested by Haman (1978, p. 89), by the dissolution of the border between originally circular openings, which could coalesce to give a "pseudo-radiate" appearance to outer edge of the aperture. Specimens of *C. akersi* in the study material have been observed to grade from a completely cribrate aperture to an aperture made up of a few central openings surrounded by a series of radiating irregular slits. No individuals found in the population had a typical radiate aperture.

The aperture of *Cribrolenticulina* Haman, 1978, therefore appears to be distinct from other "lenticuline" species in the Mexican samples. *Saracenaria toddae* Bermudez, 1949, from the study area, has an aperture similar to some specimens assigned to *Cribrolenticulina akersi* by Haman (1978). Additional studies may show that *S. toddae* should be referred to *Cribrolenticulina.*

Distribution.—*Cribrolenticulina akersi* was described from the late Pliocene section penetrated by a well in the Texas continental shelf. This species is rare in the upper Concepcion "biozone" and at locality SD-4, in the Encanto "biozone".

Genus **CRIBROROBULINA** Thalmann, 1947

Cribrorobulina serpens (Seguenza, 1880)
Plate 9, figures 1–3

Robulina serpens Seguenza, 1880, p. 143, pl. 13, fig. 25.

Cristellaria dicampyla Franzenau, 1894, p. 13, pl. 1, figs. 8a–b.

Cristellaria clericii Fornasini, 1895, p. 1, text-fig.

Robulus clericii (Fornasini). Coryell and Rivero, 1940, p. 332, pl. 43, figs. 7a–b.

Cribrorobulina serpens (Seguenza). Selli, 1941 (emend.), p. 83, pl. 1 (3), figs. 1–2, 5–10, 12–14, p. 86, text-figs. 1–2; Ruggieri and Pumo, 1964, p. 887, pl. 67, figs. 1–5.

Robulus dicampyla (Franzenau). Bermudez, 1949, p. 124, pl. 7, figs. 23, 24.

Robulus (*Cribrorobulina*) *serpens* (Seguenza). Colom, 1954, p. 232, pl. 23, figs. 2–3.

Robulus serpens (Seguenza) var. *clericii* (Fornasini). Agip Mineraria, 1957, pl. 10, fig. 8.

Cribrorobulina clericii (Fornasini). Dieci, 1959, p. 35, pl. 3, fig. 5.

Description.—Test free, planispiral, involute, biconvex, circular in side view, periphery subacute; seven to eight chambers in the last whorl, increasing gradually in size as added, chambers wedge-shaped, widest near the periphery, narrowing rapidly toward the umbo; sutures distinct, sinuate, limbate, flush with surface, at oblique angle to the periphery, making almost a 90° bend toward center of test; wall calcareous, hyaline, smooth, finely perforate; aperture terminal, at peripheral angle, consisting of numerous small round openings with a horizontal slit, in the upper portion of the apertural face below the openings, that merges with vertical opening to form an inverted "T", with a distinct lip.

Discussion.—*Cribrorobulina* Thalmann, 1947, appears to have a modified radiate aperture. The openings vary in shape from almost circular to elongate. Some individuals possess an arrangement that could be considered as a series of diverging elongate openings with a solid calcite area in the center. This variation is not a radiate aperture as defined by Loeblich and Tappan (1964a, p. C63), *i.e.,* an "opening associated with numerous diverging slits." Although the openings are elongate in some individuals, they lack the length to be considered slits. The inverted "T" aperture of this genus appears to be unique in the Nodosariidae.

Lenticulina chambersi (Garrett, 1939) may also be a *Cribrorobulina,* but the aperture was not well illustrated in the type figure. *Lenticulina chambersi* differs mainly from *C. serpens* in possessing raised sutures and prominent umbos.

Distribution.—Cribrorobulina serpens was described from the Tortonian of Calabria, Italy. It occurs in the early Pliocene of Italy; Miocene of Haiti, Spain, and Hungary; the late Miocene to early Pliocene (Gurabo Formation) of the Dominican Republic; and late Miocene to early Pliocene (Bowden Formation) of Jamaica. This species is rare in the Concepcion and Encanto "biozones".

Genus **DENTALINA** Risso, 1826

Dentalina communis d'Orbigny, 1826
Plate 7, figures 3–5

Nodosaria (Dentalina) communis d'Orbigny, 1826, p. 254, no. 35.

Nodosaria communis d'Orbigny. Cushman, 1923, p. 75, pl. 12, figs. 3, 4, 15–17.

Dentalina communis d'Orbigny. Cushman, 1930, p. 27, pl. 5, fig. 1; Cushman and Todd, 1945, p. 20, pl. 3, fig. 13; Colom, 1946a, p. 143, pl. 9, figs. 142–143; Akers and Dorman, 1964, p. 32, pl. 6, fig. 12; LeRoy, 1964, p. 23, pl. 15, fig. 28.

Enantiodentalina communis d'Orbigny. Braga, 1960, p. 132, pl. 12, fig. 17.

Description.—Test free, uniserial, slightly curved, length five to six times the width, circular in transverse section, initial end occasionally with spine; seven to nine chambers in the adult, increasing gradually in size; early chambers subglobular, later chambers inflated, becoming longer than broad; sutures oblique, depressed in later half of test; wall calcareous, hyaline, smooth, finely perforate; aperture terminal, radiate, eccentric.

Discussion.—Marks (1951, p. 45) places the following species in synonymy with *D. communis*: *D. fersthiana* Czjzek, 1848; *D. ornata* d'Orbigny, 1846; *D. botscheri* Reuss, 1863. Topotype material of these species was unavailable for comparison in the present study.

Distribution.—Dentalina communis was described from the Holocene of the Adriatic Sea. It occurs in the Holocene worldwide. Fossil occurrences are reported from the Pliocene of the Gulf of Mexico; Pliocene of Japan, Okinawa, and Italy; Miocene of the Vienna Basin; late Miocene to early Pliocene (Bowden Formation) of Jamaica; and Miocene (Choctawhatchee Formation) of Florida; Tertiary of Mallorca (Mediterranean), and Cuba. This species is rare at most localities in the Concepcion and Encanto "biozones" of the study area.

Genus **FRONDICULARIA** Defrance,
in d'Orbigny, 1826

Frondicularia cojimarensis Palmer, 1940
Plate 7, figure 8

Frondicularia sagittula Broeck var. *cojimarensis* Palmer, 1940, p. 285, pl. 53, figs. 7–8; Cushman and Renz, 1947, p. 19, pl. 5, figs. 7–8.

Frondicularia cojimarensis Palmer. Bermudez, 1949, p. 158, pl. 10, figs. 21–22.

Description.—Test free, large, as high as broad, palmate, flattened, basal margin flat to slightly concave, with short spinose projections, lateral outline gently curved; periphery rounded; chambers chevron-shaped, increasing in size gradually, numerous, ten to 14 in the megalospheric form, with a large prominent proloculus; sutures distinct, limbate, flush with surface, a few continuing as spinose projections along the basal margin; wall calcareous, hyaline, finely perforate, smooth; aperture terminal, radiate.

Discussion.—This species differs from *F. sagittula* Broeck, 1876, in its broader test and nearly horizontal basal margin.

No microspheric individuals of *F. cojimarensis* were found in the Mexican material.

Distribution.—Frondicularia cojimarensis was described from the middle to late Miocene (Cojimar Formation) of Cuba. It is also found in the early Miocene (St. Croix Formation) of Trinidad and the middle Oligocene to early Miocene (Sombrerito Formation) of the Dominican Republic. This species is rare at locality PD-64 in the upper Concepcion "biozone" and at locality SD-4 in the Encanto "biozone".

Genus **LAGENA** Walker and Jacob,
in Kanmacher, 1798

Lagena gracilis Williamson, 1848
Plate 8, figure 2

Lagena gracilis Williamson, 1848, p. 13, pl. 1, fig. 5; Cushman, 1923, p. 22, pl. 4, figs. 3, 4; Asano, 1951, p. 30, fig. 133; Asano, 1956, p. 39, pl. 5, figs. 18–20; Barker, 1960 (part), p. 119, pl. 58, figs. 2, 3, 9, 23 (not figs. 7, 8, 10, 22, 24); Murray, 1971, p. 81, pl. 31, figs. 4–6.

Description.—Test free, unilocular, elongate-fusiform in outline with a long slender neck at one end and a narrow base, which tapers to a point; length approximately six times the width; widest near center of test; circular in cross-section, sides of test nearly parallel over the central portion of test; wall calcareous, hyaline, finely perforate, ornamented with ten to 12 fine costae that disappear at the base of the neck and base of test; aperture terminal, a small round opening with a flared lip at end of a long, slender, smooth neck.

Distribution.—This species has been reported from the Holocene of the Atlantic, Pacific and Pliocene of

Japan. *Lagena gracilis* is rare in the study area and was found only at locality SD-4 in the Encanto "biozone".

Lagena hispidula Cushman, 1913
Plate 8, figure 3

Lagena hispidula Cushman, 1913, p. 14, pl. 5, figs. 2, 3; Cushman and Gray, 1946, p. 21, pl. 4, fig. 6; Cushman and McCulloch, 1950, p. 339, pl. 45, figs. 8–10; Asano, 1951, p. 31, fig. 134; Asano, 1956, p. 40, pl. 5, figs. 52–56; Todd and Brönnimann, 1957, p. 31, pl. 5, figs. 6, 7.

Description.—Test free, unilocular, circular in side view with a neck equal in length to the diameter of the test; wall calcareous, hyaline, finely perforate, ornamented by fine spines covering the entire surface; neck smooth, aperture terminal with a flaring lip at the end of a long slender neck.

Discussion.—*Lagena hispidula* differs from *Lagena hispida* Reuss, 1863, in its smooth rather than spinose neck.

Distribution.—*Lagena hispidula* has been recorded from the Holocene of the Pacific and Caribbean, and the Pliocene of Japan. This species is rare in the study area. It was found in the Concepcion and Encanto "biozones" at localities PD-35 and 40.

Lagena hoeglundi Todd and Brönnimann, 1957
Plate 8, figure 4

Lagena hoeglundi Todd and Brönnimann, 1957, p. 31, pl. 5, fig. 17.

Description.—Test free, unilocular, nearly spherical, slightly flattened at base; long slender neck equal in length to height of test; wall calcareous, hyaline, finely perforate, ornamented by 15 to 20 striae that cover the lower half of the test, basal ends of the striae projecting as fine spines in a ring at base; within this ring are additional tubercles or spines forming an inner ring; neck ornamented with raised annular costae, almost quadrate in cross-section at its midpoint and octagonal at its terminus; aperture terminal, a small round opening at the end of the neck.

Discussion.—*Lagena hoeglundi* differs from *Lagena basisenta* Cushman and Stainforth, 1945, in possessing striae on the lower half of the test and possessing a neck that is circular in cross-section.

Distribution.—*Lagena hoeglundi* was described from Holocene of the Caribbean. Specimens are rare in the study material, occurring at localities PD-46, 68, 70, and 72 in the Encanto "biozone".

Lagena laevicostata Cushman and Gray, 1946
Plate 8, figure 5

Lagena sulcata (Walker and Jacob) var. *laevicostata* Cushman and Gray, 1946, p. 68, pl. 12, figs. 13–14; Cushman and McCulloch, 1950 (part), p. 361, pl. 48, figs. 8, 9 (not fig. 10).

Lagena sulcata laevicostata Cushman and Gray. Asano, 1951, p. 33, fig. 146; Feyling-Hanssen *et al.*, 1971, p. 210, pl. 4, figs. 4–5, pl. 16, figs. 7–9.

Description.—Test free, unilocular, flask-shaped to ovate in side view, circular in cross-section; wall calcareous, hyaline, finely perforate, ornamented by 20 to 40 longitudinal costae, five of which originate near a central depression at the base and extend the length of the test, continuing up the neck, other costae intervening in position and varied in length; aperture terminal, a round opening at the end of the elongated neck; neck pentagonal in section, formed by the five extended costae.

Discussion.—The specimens from the study area are almost identical to those figured by Feyling-Hanssen *et al.* (1971, pl. 16) from the Pleistocene of Denmark. *Lagena caepulla* Schwager, 1866, differs from *L. laevicostata* in possessing a circle of short spines at its base.

Distribution.—*Lagena laevicostata* was described from the Pliocene of California. It has been recorded from the Holocene of the Pacific and the Pliocene of Japan. This species is rare in the Concepcion and Encanto "biozones".

Lagena laevis (Montagu, 1803)
Plate 8, figure 6

Serpula (*Lagena*) *laevis ovalis* Walker and Boys, 1784, p. 3, pl. 1, fig. 9.

Vermiculum laeve Montagu, 1803, p. 524 (type figure of Walker and Boys, 1784).

Lagena vulgaris Williamson, 1858, p. 3, pl. 1, figs. 5–5a; Cushman and Gray, 1946, p. 18, pl. 3, figs. 28–30.

Lagena laevis (Montagu). Cushman and McCulloch (part), 1950, p. 341, pl. 45, figs. 14, 16 (not fig. 15); Asano, 1951, p. 31, figs. 135, 136; Loeblich and Tappan, 1953, p. 61, pl. 11, figs. 5–8; Asano, 1956, p. 29, pl. 5, figs. 6, 7; Agip Mineraria, 1957, pl. 18, fig. 1; Todd and Low, 1967, p. 24, pl. 3, fig. 17.

Description.—Test free, unilocular, flask-shaped, widest near midpoint of test, circular in cross-section, base rounded, upper portion of test tapering gradually to an elongate neck that extends about one-half the length of the test; wall calcareous, hyaline, finely perforate, smooth with a very small spine at base of test; aperture terminal, rounded, at the end of the neck, with an everted lip.

Discussion.—*Lagena vulgaris* Williamson, 1858, is an objective synonym of *L. laevis* (Montagu, 1803). Williamson proposed changing the trivial name to *vulgaris* to include variously-ornamented forms in the same species (Loeblich and Tappan, 1953, p. 62).

Distribution.—*Lagena laevis* has been recorded from the Holocene of the Pacific and Atlantic; Pleistocene of California; Pliocene of Japan and Italy. This species is rare in the Concepcion and Encanto "biozones" of the study area.

Lagena rudis Reuss, 1863
Plate 8, figure 7

Lagena rudis Reuss, 1863, p. 336, pl. 6, fig. 82.

Description.—Test free, unilocular, ovate in side view, circular in transverse section; wall calcareous, hyaline, finely perforate, entire test ornamented with irregularly-spaced nodes and blunt spines that decrease in size toward the apertural end, the area surrounding the aperture smooth; aperture terminal, a small round opening in center of flattened circular area at top of test.

Discussion.—*Lagena rudis* Reuss, 1863, is similar to *Lagena aspera* Reuss, 1862, from the Cretaceous of the Netherlands, and the two species may be conspecific. *Lagena asperoides* Galloway and Morrey, 1929, differs from *L. rudis* in possessing a long tapering neck and a phialine lip.

Distribution.—*Lagena rudis* was described from the Pliocene of Belgium. It is rare at locality SD-4 in the Encanto "biozone".

Lagena setigera Millett, 1901
Plate 8, figure 8

Lagena clavata (d'Orbigny) var. *setigera* Millett, 1901, p. 491, pl. 8, figs. 9a–b.

Lagena perlucida (Montagu) var. Cushman and McCulloch, 1950, p. 343, pl. 46, figs. 3, 4 (not *Vermiculum perlucidum* Montagu, 1803).

Lagena setigera Millett. Loeblich and Tappan, 1953, p. 66, pl. 11, figs. 23–24.

Lagena laevis (Montagu) var. Barker, 1960, p. 116, fig. 30 (not *Vermiculum laeve* Montagu, 1803).

Description.—Test free, unilocular, fusiform, widest near midpoint of test, circular in cross-section, base tapering, upper portion of test with an elongate neck; wall calcareous, hyaline, finely perforate, smooth, except for a circlet of small spines surrounding a small depression at base of test; aperture terminal, a small round opening surrounded by a thickened lip at end of a slender neck.

Discussion.—*Lagena setigera* is distinguished by a small depression at base of test surrounded by a circle of spines.

Distribution.—This species was described from the Holocene of the Malay Archipelago. It has also been recorded from the Holocene of the Arctic Ocean and the central Pacific; and the Pleistocene of Denmark. In the study area it is rare, occurring only in the Concepcion "biozone".

Lagena spirata Bandy, 1949
Plate 8, figure 9

Lagena sulcata (Walker and Jacob). Cushman, 1923, p. 57, pl. 11, fig. 1.

Lagena sulcata (Walker and Jacob) var. *spirata* Bandy, 1949, p. 57, pl. 7, fig. 18; LeRoy, 1964, p. 25, pl. 13, figs. 32, 38.

Lagena laevis (Montagu). Barker, 1960, p. 118, pl. 57, fig. 23 (not Montagu, 1803).

Lagena spirata Bandy. Andersen, 1961, p. 78, pl. 16, fig. 15; Poag, 1966, p. 403, pl. 2, figs. 23–24.

Description.—Test free, unilocular, subglobular, slightly longer than broad, circular in cross-section; wall calcareous, hyaline, finely perforate, ornamented with approximately 15 to 20 fine longitudinal costae extending from the base of the test to the base of the neck, 20 or more other costae intervening in position and varied in length; several costae extend the length of test from the base to the neck where they are spirally wound about the neck; aperture terminal, a simple circular opening at the end of the neck.

Discussion.—Specimens of *L. spirata* from the study area differ from the type figure of Bandy (1949). They have more finely-developed longitudinal costae with additional fine costae intervening in position and varying in length.

Lagena spirata is distinguished by the spiral costae continuing the length of the neck.

Distribution.—This species has been reported from the Holocene of the Atlantic and Pacific; the Pleistocene and Eocene of the Gulf Coast; and the Pliocene of Okinawa. This species is rare in the lower Concepcion "biozone" occurring only at locality PD-45.

Lagena striata basisenta
Cushman and Stainforth, 1945
Plate 8, figure 1

Lagena striata (d'Orbigny) var. *basisenta* Cushman and Stainforth, 1945, p. 29, pl. 4, fig. 15.

Description.—Test free, unilocular, ovate in side view, circular in transverse section; wall calcareous, hyaline, finely perforate, ornamented by 40 to 50 fine longitudinal costae, 20 or more continue from base of neck to an area near the base of the test, other costae intervening in position and varied in length; the base of test with six or more short spines, neck ornamented by a series of annular costae; aperture terminal, a small round opening at end of the neck.

Discussion.—*Lagena striata basisenta* differs from *Lagena striata* (d'Orbigny, 1839b) in possessing short spines at the base of the test and a neck ornamented by rings.

Distribution.—*Lagena striata basisenta* was described from the Oligo-Miocene (Cipero Formation) of Trinidad. It is rare in the study area, occurring at locality PD-54 in the lower Concepcion "biozone" and at localities PD-35 and 46 in the Encanto "biozone".

Genus **LANKESTERINA**
Loeblich and Tappan, 1961

Lankesterina frondea (Cushman, 1922)
Plate 7, figures 6–7

Bolivina frondea Cushman, 1922c, p. 126, pl. 29, fig. 3.
Polymorphina frondea (Cushman). Cushman and Ozawa, 1930, p. 118, pl. 30, figs. 11a–b; Cushman and McGlamery, 1942, p. 68, pl. 5, figs. 5–7; Cushman and Ellisor, 1945, p. 559, pl. 74, fig. 19.
Lankesterina frondea (Cushman). Poag, 1966, p. 403, pl. 2, figs. 25–26.

Description.—Test free, small, compressed, broad in side view, length slightly greater than width, biserial throughout, flattened in transverse section with truncate margins; chambers compressed, elongate, six to nine pairs of chambers in adult, increasing rapidly in size; sutures distinct, limbate, slightly raised in later portion to form a rim around margin of the ultimate and penultimate chambers; wall calcareous, hyaline, smooth, very finely perforate; aperture terminal, radiate.

Discussion.—*Lankesterina frondea* is distinguished by its bilateral symmetry, biserial chamber arrangement and truncated margins. *Dyofrondicularia* Asano, 1936b, differs from *Lankesterina* Loeblich and Tappan, 1961, in possessing an early uniserial stage.

Distribution.—This species is recorded from the Miocene and Oligocene of the Gulf Coastal Plain. It occurs in low frequencies at locality SD-4 and PD-35 in the Encanto "biozone" and may be reworked from older strata in the study area.

Genus **NODOSARIA** Lamarck, 1812

Nodosaria catesbyi d'Orbigny, 1839
Plate 6, figure 1

Nodosaria (*Nodosaria*) *catesbyi* d'Orbigny, 1839a, *in* Sagra, p. 16, pl. 11, figs. 8–10.
Nodosaria proxima Silvestri, 1872, p. 63, pl. 6, figs. 138–147.
Nodosaria catesbyi d'Orbigny. Cushman, 1930, p. 28, pl. 5, fig. 4; Todd and Brönnimann, 1957, p. 31, pl. 5, fig. 4; Boltovskoy, 1959, p. 65, pl. 8, fig. 10; Bermudez and Seiglie, 1963, p. 104, pl. 17, fig. 4.
Lagenonodosaria catesbyi (d'Orbigny). LeCalvez, 1977, p. 47, p. 48, figs. 1–5.

Description.—Test free, uniserial, length slightly greater than twice the width, circular in transverse section; composed of two to three chambers, initial chamber subglobular, ultimate chamber pyriform; sutures distinct, depressed, horizontal; wall calcareous, hyaline, finely perforate, ornamented with nine to ten distinct costae that extend from a short spine at the base of initial chamber and continue the entire length of the test and along the neck; aperture terminal, radiate, with a phialine lip at the end of a short neck.

Discussion.—Sabol (1960) emended the description of *N. catesbyi* to include specimens that have more than two chambers. He noted that populations from the Yorktown Formation varied in form from two to four chambers. This he considered to be an intraspecific variation. The specimens from the study area have two to three chambers.

Distribution.—*Nodosaria catesbyi* was described from the Holocene of Cuba. It is reported from the Holocene of the Atlantic and Caribbean; as *N. proxima* from the Pliocene of Italy; the Miocene (Choctawhatchee Formation) of Florida and the Pliocene (Yorktown Formation) of Virginia. It is rare in the study area, only occurring at locality SD-4 in Encanto "biozone".

Nodosaria glandulinoides Neugeboren, 1852
Plate 6, figure 2

Nodosaria glandulinoides Neugeboren, 1852, p. 37, pl. 1, fig. 2.
Nodosaria sp. (?). Cushman and Jarvis, 1930, p. 361, pl. 33, fig. 2.
Dentalina cf. *consobrina* d'Orbigny. Cushman and Todd, 1945 (part), p. 21, pl. 3, fig. 17 (not fig. 18).

Description.—Test free, large, uniserial, elongate, length four times the width, circular in transverse section, initial end broadly rounded; chambers highly inflated, almost spherical, three to four arranged in a rectilinear series, overlapping with a slight constriction between chambers; ultimate chamber slightly tapering to the apertural end; sutures indistinct, because of embracing nature of chambers; wall calcareous, hyaline, smooth, finely perforate; aperture terminal, radiate, with a broad platelike process raised above the ultimate chamber by eight solid bars evenly spaced around the plate, with openings in between.

Discussion.—*Nodosaria glandulinoides* is distinguished by the smooth, strongly-overlapping chambers and the protruding radiate aperture with a distinct platelike process (Pl. 6, figs. 2c–d).

Nodosaria soluta Bornemann, 1855, from the Tertiary of Germany, differs from *N. glandulinoides* in its acuminate initial chamber, greater constriction between chambers and absence of a platelike process over the aperture.

Distribution.—*Nodosaria glandulinoides* was described from the Tertiary of Romania. It is also recorded from the late Miocene to early Pliocene (Bowden Formation) of Jamaica. This species is rare in the study area, restricted to the Encanto "biozone" at localities SD-4, PD-35, 46, 52, and 72.

Nodosaria longiscata d'Orbigny, 1846
Plate 6, figure 3

Nodosaria longiscata d'Orbigny, 1846, p. 32, pl. 1, figs. 10–12; Franklin, 1944, p. 311, pl. 46, figs. 1, 2; Cushman and Todd, 1945, p. 25, pl. 4, figs. 8–10; Cushman and Stainforth, 1945, p. 24, pl. 3, figs. 19–21; Colom, 1946b, p. 65, pl. 8, figs. 189–190; Bermudez, 1949, p. 145, pl. 9, fig. 57; Becker and Dusenbury, 1958, p. 18, pl. 3, fig. 6; LeRoy, 1964, p. 24, pl. 15, fig. 23.

Nodosaria arundinea Schwager, 1866, p. 211, pl. 5, figs. 43–45.

Nodosaria calamus Silvestri, 1872, p. 87, pl. 10, figs. 243–251.

Description.—Test free, uniserial, slender, fragile; chambers cylindrical, length approximately seven times the width, inflated; sutures distinct, horizontal, slightly depressed; wall smooth, calcareous, finely perforate; aperture terminal, radiate.

Discussion.—All specimens from the study area were fragmentary. Those specimens that have a proloculus exhibit the bulbous primary chamber as figured by Bermudez (1949). Franklin (1944) reported that the aperture of *N. longiscata* is radiate; however, no specimens with intact apertures were encountered in the present study.

Nodosaria arundinea Schwager, 1866, and *N. calamus* Silvestri, 1872, have been placed in synonymy by Marks (1951) and Cushman and Todd (1945), and their example has been followed herein. There are four species of *Nodosaria,* named and figured by Neugeboren (1852) from the Tertiary of Romania, that look similar to *N. longiscata* and may be junior synonyms.

Distribution.—Nodosaria longiscata was described from the Tertiary of the Vienna Basin. It is reported from the Tertiary of Italy; Burdigalian of Mallorca; Oligo-Miocene (Meson and Alazan formations) of Mexico; Oligocene (Carapita Formation) of Venezuela; and Neogene (Shimajiri Formation) of Okinawa. It is rare at most localities in the lower Concepcion and Encanto "biozones".

Nodosaria pyrula d'Orbigny, 1826
Plate 6, figure 4

Nodosaria pyrula d'Orbigny, 1826, p. 253 [not figured; see Parker, Jones, and Brady, 1871, fig. 37]; Cushman, 1923, p. 69, pl. 16, figs. 1–4; Cushman and Todd, 1945, p. 28, pl. 4, figs. 17, 18; Asano, 1956, p. 20, pl. 4, figs. 40–42; Becker and Dusenbury, 1958, p. 19, pl. 3, fig. 4; Akers and Dorman, 1964, p. 46, pl. 6, fig. 19; Bermudez, 1949, p. 147, pl. 9, fig. 55.

Description.—Test free, uniserial, elongate, circular in transverse section; chambers numerous, in a straight or slightly-curved series, spherical to pear-shaped, nearly all the same size, separated by long, narrow tubular necks; sutures indistinct; wall smooth, calcareous, hyaline, finely perforate; aperture terminal, radiate, composed of six to seven bars connected at the apex, with openings in between.

Discussion.—All specimens collected from the study area were broken. The illustrated specimen (Pl. 6, fig. 4a) shows the detail of the aperture and the distinctive radiate configuration.

Nodosaria guttifera (d'Orbigny, 1846) is similar to *N. pyrula* and may be a junior synonym.

Distribution.—Nodosaria pyrula was described from the Tertiary of Italy. It has been recorded from the Holocene of the Atlantic, Pacific and Caribbean; Holocene and Pleistocene of the Gulf of Mexico; Pliocene of Japan; Tertiary of Colombia; late Miocene to early Pliocene (Bowden Formation) of Jamaica; late Miocene to early Pliocene (Gurabo Formation) of the Dominican Republic; Oligo-Miocene (Cipero Formation) of Trinidad; and middle to late Miocene (Cojimar Formation) of Cuba. This species is rare in the Concepcion and Encanto "biozones".

Nodosaria cf. **N. subtertenuata** Schwager, 1866
Plate 6, figure 5

Nodosaria subtertenuata Schwager, 1866, pt. 2, p. 235, pl. 6, fig. 74.

Description.—Test free, uniserial, elongate, slender, circular in cross-section; chambers distinct, inflated, six to seven in the adult, arranged in a rectilinear series, initial chamber spherical, larger than the succeeding chamber, the remainder of the chambers increasing rapidly in size, the ultimate chamber spherical and almost twice the diameter of the penultimate chamber, all chambers slightly embracing; sutures indistinct, horizontal, wall calcareous, hyaline, finely perforate, ornamented by small downward-projecting spines on the early chambers and proloculus, projecting outward from the ultimate chamber, randomly arranged; aperture terminal, an irregular folded opening with inward projections, at the end of a long fragile spinose neck that is equal in length to the diameter of the ultimate chamber.

Discussion.—The Mexican specimens closely resemble *Nodosaria subtertenuata* described by Schwager from the Pliocene of Car Nicobar.

A form from the Bowden Formation of Jamaica assigned to *Nodosaria papillosa* Silvestri, 1872, by Cushman and Todd (1945, pl. 4, fig. 5) is similar to the Mexican specimens but unlike the type figure of *N. papillosa.*

An illustration in Agip Mineraria (1957, pl. 25, fig. 3), identified as *Orthomorphina stainforthi* Perconig, 1955, is almost identical to specimens from the present study.

Distribution.—Nodosaria cf. *N. subtertenuata* is rare at localities PD-58, 68, and 72 in the Encanto "biozone".

Nodosaria tosta Schwager, 1866
Plate 6, figures 6–7

Nodosaria tosta Schwager, 1866, p. 219, pl. 5, fig. 42; Cushman, Stewart, and Stewart, 1930, p. 55, pl. 3, fig. 1; LeRoy, 1941a, p. 27, pl. 3, fig. 91; LeRoy, 1964, p. 23, pl. 15, fig. 1.
Nodosaria gemina Silvestri, 1872 (part), p. 67, pl. 7, figs. 165–166, 168–169 (not figs. 159–164, 167, 170–172, 172a–e).
Nodosaria sinalata Finlay, 1940, pt. 1, p. 452, pl. 63, fig. 49.
Nodosaria? sp. Bermudez, 1949, p. 149, pl. 9, fig. 66.

Description.—Test free, uniserial, pentagonal in cross-section, elongate and thin, increasing in width as later chambers are added; proloculus subglobular with a constriction above; later chambers gradually increasing in size with the length four times the width; sutures distinct, horizontal; wall calcareous, hyaline, finely perforate, with five to eight twisted platelike longitudinal costae, apertural end broken.

Discussion.—Nodosaria tosta is a distinctive species with the characteristic twisted costae and pentagonal cross-section. Because the test is quite fragile, a specimen with an intact final chamber was not found in the study material.

Silvestri (1872) grouped two distinct species under the name *Nodosaria gemina.* The non-flattened form appears identical to the type figure of *N. tosta* Schwager, 1866.

Distribution.—Nodosaria tosta was described from the Pliocene of Car Nicobar. This species is recorded from the late Tertiary of east Borneo, Dominican Republic, upper Bavaria and Humboldt County, California; the Neogene (Shimajiri Formation) of Okinawa; as *N. gemina* from the Tertiary of Italy; and as *N. sinalata* from early Pliocene of New Zealand.

Nodosaria tosta is rare in the study area, restricted to the Encanto "biozone" at localities PD-35, 58, 68, and 72.

Nodosaria vertebralis (Batsch, 1791)
Plate 6, figures 8–9

Nautilus (Orthoceras) vertebralis Batsch, 1791, pl. 2, fig. 6.
Nodosaria vertebralis (Batsch). Cushman, 1923, p. 86, pl. 14, fig. 6; Hedberg, 1937, p. 671, pl. 91, fig. 2; Bermudez, 1949, p. 149, pl. 9, fig. 54; Renz, 1948 (part), p. 147, pl. 5, figs. 10, 11 (not figs. 8, 9).
Dentalina vertebralis (Batsch). Cushman and Todd, 1945, p. 21, pl. 3, fig. 20; Becker and Dusenbury, 1958, p. 18, pl. 2, fig. 12.

Description.—Test free, uniserial, length eight times the width, slightly curved, ovate in cross-section; proloculus inflated, larger than the next chamber with a constriction at the junction of the two; chambers distinct, eight to nine in the adult, inflated on the later one-third of test; sutures distinct, broad, slightly depressed near the apertural end, perpendicular to axis of growth; wall calcareous, hyaline, finely perforate, ornamented by six to nine broad longitudinal costae that continue to the apertural end, initial chamber with a short blunt spine; aperture eccentric, slightly produced, radiate with six prominent slits.

Discussion.—Nodosaria vertebralis albatrossi Cushman, 1923, differs from *N. vertebralis* in possessing 15 to 18 costae instead of six to nine.

Cushman and Todd (1945, p. 22) include *Nodosaria acuta* (d'Orbigny, 1846) from the Tertiary of the Vienna Basin in their synonymy of *N. vertebralis.*

Distribution.—Nodosaria vertebralis was described from the Holocene of the Adriatic Sea. It is also recorded from the Holocene of the Gulf of Mexico and Atlantic; Tertiary of Colombia; Oligo-Miocene (Carapita and San Lorenzo formations) of Venezuela, late Miocene to early Pliocene (Bowden Formation) of Jamaica, the late Oligocene (Trinchera Formation) of Dominican Republic, and middle to late Miocene (Cojimar Formation) of Cuba. It is rare in the lower Concepcion and Encanto "biozones".

Genus **PSEUDONODOSARIA** Boomgaart, 1949

Pseudonodosaria comatula (Cushman, 1923)
Plate 7, figure 10

Nodosaria comatula Cushman, 1923, p. 83, pl. 14, fig. 5.
Pseudoglandulina comatula (Cushman). Hedberg, 1937, p. 673, pl. 91, figs. 9–10; Cushman and Todd, 1945, p. 29, pl. 4, fig. 25; Bermudez, 1949, p. 161, pl. 10, fig. 41; Phleger and Parker, 1951, p. 10, pl. 5, figs. 7–9; Todd and Low, 1976, p. 24, pl. 3, fig. 18.
Pseudonodosaria comatula (Cushman). Becker and Dusenbury, 1958, p. 134, pl. 64, figs. 1–5.
Rectoglandulina comatula (Cushman). Barker, 1960, p. 134, pl. 64, figs. 1–5.

Description.—Test free, elongate, uniserial, rectilinear, length twice the width, periphery slightly lobate, circular in transverse section; chambers inflated, strongly embracing, three to five chambers in the adult; sutures distinct, somewhat depressed, horizontal; wall calcareous, hyaline, finely perforate, ornamented with 30 to 40 longitudinal costae, continuous from one chamber to another, the initial end with small central spine, the final one-third of the ultimate chamber is smooth; aperture terminal, radiate.

Discussion.—Pseudonodosaria tenuistriata (Bermudez, 1949) differs from *P. comatula* in possessing a non-lobate outline in side view, more numerous fine costae, and larger last chamber comprising about three-fourths of the test.

Distribution.—Pseudonodosaria comatula was described from the Holocene of the Gulf of Mexico. It is recorded from the Holocene of the Caribbean and the Atlantic, Pleistocene of the Gulf of Mexico, the early Miocene (San Lorenzo Formation) and Oligocene (Carapita Formation) of Venezuela, the Tertiary of Colombia and Puerto Rico, the late Miocene to early

Pliocene (Bowden Formation) of Jamaica, and middle Pliocene (Mao Formation) of the Dominican Republic. It is rare in the Encanto "biozone" occurring at localities PD-35, 46, 52, and 56.

Subfamily **PLECTOFRONDICULARIINAE** Cushman, 1927a

Genus **AMPHIMORPHINA** Neugeboren, 1850

Amphimorphina stainforthi (Cushman and Renz, 1941)

Plate 9, figures 4–5

Nodosaria stainforthi Cushman and Renz, 1941, p. 15, pl. 3, fig. 4; Cushman and Stainforth, 1945, p. 25, pl. 3, fig. 25; Cushman and Ellisor, 1945, p. 556, pl. 74, fig. 5; Cushman and Renz, 1947, p. 16, pl. 4, fig. 20; Renz, 1948, p. 147, pl. 4, figs. 31a–b; Bermudez, 1949, p. 148, pl. 9, fig. 50; Becker and Dusenbury, 1958, p. 19, pl. 2, fig. 13.

Description.—Test free, elongate, initial end acute, length seven to eight times the width, circular to hexagonal in transverse section; chambers numerous, 11 to 18 in the adult, slightly longer than broad, increasing rapidly in size as added, inflated in latter half of test, sutures distinct, horizontal, slightly limbate, depressed in latter half of test; wall calcareous, hyaline, finely perforate, ornamented by six to seven thin, platelike longitudinal costae that extend the entire length of test; aperture terminal, at center of thickened polygonal rim, a series of openings between the ten to 14 ribs projecting inward from the rim to center of aperture.

Discussion.—The aperture is not a simple radiate one. High magnification shows that the ribs alternate in size, the longer and thicker ones aligned approximately with the longitudinal costae, and the shorter ribs positioned between (see Pl. 9, fig. 4c). In dissected individuals (Pl. 9, fig. 5), the aperture of the penultimate chamber exhibits a convergence of the ribs to form a cribrate aperture indicative of the genus *Amphimorphina.*

Distribution.—*Amphimorphina stainforthi* (Cushman and Renz) was described from the Miocene (Pozon Formation) of Venezuela. It has been recorded from the Oligo-Miocene (Cipero Formation) and early Miocene (St. Croix Formation) of Trinidad, Oligo-Miocene (Sombrerito and Trinchera formations) of the Dominican Republic, and the Goajira Peninsula of Colombia.

This species appears to be restricted to the Caribbean and Gulf of Mexico areas. It is found in low frequencies at most localities in the Encanto "biozone".

Genus **PLECTOFRONDICULARIA** Liebus, 1902

Plectofrondicularia advena (Cushman, 1923)

Plate 9, figures 8–9

Frondicularia inaequalis Costa. Cushman, 1921, p. 216, pl. 40, figs. 5–6 (not Costa, 1855).

Frondicularia advena Cushman, 1923, p. 141, pl. 20, figs. 1–2; Galloway and Wissler, 1927, p. 47, pl. 8, figs. 7–8; Cushman, Stewart, and Stewart, 1930, p. 57, pl. 3, fig. 5; Cushman and Gray, 1946, p. 15, pl. 3, fig. 16.

Parafrondicularia advena (Cushman). Barker, 1960, p. 138, pl. 66, figs. 8–12.

Description.—Test free, elongate, compressed, with keel, triangular in side view, widest at the distal end, apical angle about 10 to 35°; microspheric form biserial in early stage, adult uniserial; megalospheric form uniserial throughout with subspherical proloculus; chambers distinct, nine to 14 in the adult, increasing gradually in size, chevron-shaped; sutures distinct, slightly depressed, not limbate, moderately curved; wall calcareous, hyaline, smooth, very finely perforated, megalospheric form ornamented with short median costa on the first four chambers; aperture radiate at end of the last-formed chamber.

Discussion.—The Mexican specimens differ from the typical forms described by Cushman from the Atlantic Holocene, in possessing a very short median costa on the first few chambers of the megalospheric form.

Plectofrondicularia goharai Kuwano, 1950, from the Pliocene of Japan is similar to *P. advena* but has two to three short costae at the initial end.

Plectofrondicularia vaughani Cushman, 1927b, differs from *P. advena* in the much greater width-to-height ratio, that causes the species to appear broadly elliptical in side view.

Distribution.—*Plectofrondicularia advena* is recorded from the Holocene of the Atlantic and Pacific; Pleistocene, Pliocene, and Miocene of California. This species occurs at most localities of the Concepcion and Encanto "biozones".

Plectofrondicularia floridana Cushman, 1930

Plate 9, figures 6–7

Plectofrondicularia floridana Cushman, 1930, p. 41, pl. 8, fig. 1; Cushman and Cahill, 1933, p. 22, pl. 7, fig. 11; Renz, 1948, p. 152, pl. 6, fig. 19; Bermudez, 1949, p. 175, pl. 11, fig. 42; Redmond, 1953, p. 719, pl. 75, figs. 1a–b; Becker and Dusenbury, 1958, p. 31, pl. 3, fig. 8; Akers and Dorman, 1964, p. 48, pl. 7, figs. 23, 24.

Plectofrondicularia japonica Asano, 1953b, p. 54; p. 53, text-figs. 9–10.

Description.—Test free, elongate, length about four times the width, strongly compressed, biserial in early stage, adult uniserial, initial end rounded; periphery keeled, with three platelike carinae, one in the middle, in the plane of compression, the other two perpendicular to the middle one; chambers distinct, two to three pairs in early biserial portion, chambers in uniserial portion wider than high, increasing in size gradually toward the apertural end; sutures limbate, each half extending downward then becoming almost perpendicular to outer margin of test; wall calcareous, finely perforate, smooth except for a median costa that is restricted to the biserial portion of test; aperture terminal, radiate, with 11 to 13 ribs projecting into the aperture.

Discussion.—Plectofrondicularia californica Cushman and Stewart, 1926, differs from *P. floridana* in its narrower and more oblique sutures.

Distribution.—Plectofrondicularia floridana was described from the Miocene (Choctawhatchee Formation) of Florida. It is recorded from the Pleistocene and Miocene of the Gulf Coast; Tertiary of Colombia; early Miocene (San Lorenzo Formation) of Venezuela; late Oligocene (Trinchera Formation) of the Dominican Republic; it is reported as *P. japonica* from the Miocene of Japan. *Plectofrondicularia floridana* occurs at most localities in the Concepcion and Encanto "biozones".

Subfamily **LINGULININAE**
Loeblich and Tappan, 1961

Genus **LINGULINA** d'Orbigny, 1826

Lingulina ponceana Galloway and Heminway, 1941
Plate 9, figure 10

Lingulina ponceana Galloway and Heminway, 1941, p. 352, pl. 11, figs. 11a–b.

Description.—Test free, uniserial throughout, moderately compressed, ovate in side view, not lobulate, greatest width near middle of test, slightly longer than broad, lenticular in transverse section; periphery acute with a distinct keel; chambers few, three to four in the adult, increasing in size rapidly as added, strongly overlapping; sutures indistinct, flush with surface, slightly curved; wall calcareous, hyaline, smooth, finely perforate; aperture terminal, an elongate slit, extending one-half the width of the test, parallel to the plane of compression, slightly produced.

Discussion.—All the specimens of this species recovered from the study area were broken. The specimen figured in Plate 9, figure 10 lacks the final chamber.

Lingulina fugeshiensis Asano, 1953a, is similar to *L. ponceana* but has a much larger test.

Distribution.—Lingulina ponceana was described from the early Miocene (Ponce Formation) of Puerto Rico. This species is rare and occurs only at locality SD-4 in the Encanto "biozone", and may be reworked from older strata.

Genus **LINGULINOPSIS** Reuss, 1860a

Lingulinopsis cf. **L. cubensis**
(Cushman and Bermudez, 1937)
Plate 9, figure 11

Lingulina cubensis Cushman and Bermudez, 1937, p. 11, pl. 1, fig. 38.

Description.—Test free, fairly large, early portion coiled, later uncoiling, becoming uniserial, moderately compressed, lenticular in transverse section, periphery keeled, asymmetrical in side view; chambers distinct, slightly inflated, five to seven in the adult, four in the initial coil, one to three in the uniserial portion, overlapping, increasing rapidly in size as added, the ultimate chamber making up almost one-half of the test; sutures indistinct in the coiled portion, later becoming distinct and slightly depressed, curved; wall calcareous, hyaline, smooth, finely perforate; aperture terminal, an elongate slit, slightly off center, parallel to the plane of compression, with a raised margin.

Discussion.—Lingulinopsis cubensis (Cushman and Bermudez, 1937) differs from the Mexican specimens in its circular outline and smaller size. Cushman and Bermudez (1937) state in the type description that *L. cubensis* has a radiate aperture, but they compare their species to *Lingulina mexicana* Cole, 1927, which has a distinct elongate aperture characteristic of the subfamily Lingulininae of Loeblich and Tappan. The type description of Cushman and Bermudez is evidently in error.

Distribution.—Lingulinopsis cubensis was described from the Eocene of Cuba. In the study area, *Lingulinopsis* cf. *L. cubensis* is rare at locality SD-4 in the Encanto "biozone", and may be reworked from older strata.

Family **VAGINULINIDAE** Reuss, 1860b

Subfamily **LENTICULININAE**
Chapman, Parr, and Collins, 1934

Genus **LENTICULINA** Lamarck, 1804

Lenticulina atlantica (Barker, 1960)
Plate 10, figures 1–2

Cristellaria lucida Cushman, 1923, p. 111, pl. 30, fig. 2.
Robulus melvilli Cushman and Renz. Cushman and Todd, 1945, p. 16, pl. 2, fig. 12 (not Cushman and Renz, 1941).
Robulus lucidus (Cushman). Bermudez, 1949, p. 128, pl. 7, figs. 31–32; Asano, 1951, p. 5, text-figs. 21–22; Asano, 1956 (part), p. 48, pl. 1, figs. 16a–b (not figs. 15a–b; 17, 18).
Robulus atlanticus Barker, 1960 (*nom. nov.*), p. 144, pl. 69, figs. 10–12.
Lenticulina atlantica (Barker). Akers and Dorman, 1964, p. 40, pl. 4, figs. 13, 14.

Description.—Test free, planispiral, involute, biconvex in ventral view, circular in side view, periphery keeled; seven to eight chambers in the last whorl, increasing gradually in size as added, central portion of test transparent, revealing the earlier coils; sutures slightly depressed, slightly curved, extending to edge of transparent area in umbilicus; wall calcareous, hyaline, smooth, finely perforate; aperture radiate, at peripheral angle, with a vertical robuline slit extending downward in the apertural face with a finlike projection on either side.

Discussion.—Lenticulina lucida (Cushman, 1923) is a secondary homonym of *Lenticulina lucida* (Seguenza, 1880). Barker (1960, p. 144) proposed *Robulus atlanticus* as a new name for *L. lucida* (Cushman). The specimens figured by Brady and assigned to *L. lucida* by Cushman differ from Cushman's type figure in not possessing a well-developed keel although the specimens do exhibit the transparent area revealing the earlier coils.

Lenticulina lowmani (Andersen, 1961) is similar to *L. atlantica* but lacks the transparent umbilical area.

Distribution.—This species was described from the Holocene of the Atlantic. It is also recorded from the Holocene of the Pacific, the Pleistocene of the Gulf Coast, Pliocene of Japan; late Miocene to early Pliocene (Gurabo Formation) of the Dominican Republic, and the late Miocene to early Pliocene (Bowden Formation) of Jamaica. *Lenticulina atlantica* is rare in the Concepcion and Encanto "biozones".

Lenticulina bowdenensis (Cushman, 1919)
Plate 10, figure 3

Cristellaria bowdenensis Cushman, 1919, p. 37, pl. 8, fig. 2.
Cristellaria antillea Cushman, 1923, p. 116, pl. 31, fig. 1, pl. 32, fig. 1, pl. 33, fig. 1; pl. 34, fig. 1.
Robulus bowdenensis (Cushman). Bermudez, 1949, p. 121, pl. 7, figs. 7–8; Andersen, 1961, p. 47, pl. 12, figs. 4a–b.
Lenticulina bowdenensis (Cushman). Akers and Dorman, 1964, p. 40, pl. 4, figs. 22–26.

Description.—Test free, large, planispiral, involute, biconvex in edge view, circular in side view: periphery acute and keeled; eight to nine chambers in the last whorl, increasing gradually in size as added; sutures raised, strongly curved, with tubercles along the sutures near the periphery, sutures of the last few chambers flush with surface; wall calcareous, hyaline, finely perforate, ornamented with small tubercles along the outer margin of the chambers next to the keel, some tubercles on chamber walls between sutures; apertural face flat with a terminal radiate aperture at peripheral angle.

Discussion.—Surface ornamentation in *L. bowdenensis* varies greatly, consisting of tubercles on the chamber and keel as well as peripheral spines on some specimens.

Distribution.—Lenticulina bowdenensis was described from the late Miocene to early Pliocene (Bowden Formation) of Jamaica. It is recorded from the Holocene of the Gulf of Mexico and Atlantic, Pleistocene of the Gulf Coast, and the late Miocene to early Pliocene (Gurabo Formation) of the Dominican Republic. This species is rare in the Encanto "biozone" occurring only at locality SD-4.

Lenticulina calcar (Linnaeus, 1758)
Plate 10, figures 4–5

Nautilus calcar Linnaeus, 1758, p. 709.
Cristellaria calcar Linnaeus. Cushman, 1923, p. 115, pl. 30, fig. 7, pl. 31, figs. 4, 5.
Robulus calcar (Linneo) [*sic*]. Colom, 1946a, p. 138, pl. 5, fig. 56; Renz, 1948, p. 158, pl. 3, fig. 6; Bermudez, 1949, p. 122, pl. 6, figs. 51–54; Andersen, 1961 (part), p. 48, pl. 11, figs. 1a–b (not figs. 2a–b).
Lenticulina calcar (Linnaeus). Barker, 1960, p. 146, pl. 70, figs. 9–12; Akers and Dorman, 1964, p. 41, pl. 4, fig. 8.

Description.—Test free, planispiral, involute, biconvex in edge view, subcircular in side view, periphery keeled with a single spine generally opposite each chamber in final whorl; chambers slightly inflated, increasing gradually in size as added, five to seven in the final whorl; sutures limbate, flush with surface, slightly curved, converging in the umbilical area; wall calcareous, hyaline, smooth, finely perforate, peripheral keel ornamented with radial spines; aperture radial at peripheral angle having a vertical slit with a lip extending downward in the apertural face.

Discussion.—Lenticulina calcar differs from *Lenticulina spinosa* (Cushman, 1918b) in not possessing elevated sutures and umbilical bosses.

Distribution.—Lenticulina calcar was described from the Holocene of the Adriatic Sea. It is recorded from the Holocene of the Atlantic, Pacific, Gulf of Mexico, and Caribbean; Pleistocene of the Gulf Coast; Oligocene and late Miocene (Carapita and Pozon formations) of Venezuela; Vindobonian of Mallorca; late Miocene to early Pliocene (Gurabo Formation) of the Dominican Republic; late Miocene to early Pliocene (Bowden Formation) of Jamaica; and middle to late Miocene (Cojimar Formation) of Cuba. This species is rare at most localities in the Concepcion and Encanto "biozones".

Lenticulina cultrata (Montfort, 1808)
Plate 10, figures 6–7

Robulus cultratus Montfort, 1808, p. 215, text-fig; Dieci, 1959, p. 29, pl. 2, figs. 15–16.
Cristellaria cultrata (Montfort). Cushman, 1913, p. 64, pl. 29, fig. 4.
Cristellaria iota Cushman, 1923, p. 111, pl. 29, fig. 2, pl. 30, fig. 1.
Robulus cf. *cultratus* Montfort. Cushman and Todd, 1945, p. 16, pl. 2, figs. 14a–b.

Robulus cf. *R. cultratus* Montfort. Andersen, 1961, p. 49, pl. 13, figs. 2a–b.
Lenticulina cultrata (Montfort). Akers and Dorman, 1964, p. 41, pl. 4, fig. 21.

Description.—Test free, planispiral, involute, biconvex in edge view, circular in side view; periphery with thin keel; five to seven chambers in the final whorl, increasing in size as added, central portion of test with opaque umbilical plug; sutures distinct, flush with surface, radial and tangential to opaque umbilical area; wall calcareous, hyaline, smooth, finely perforate; aperture radiate, at peripheral angle with a robuline slit projecting down into the upper portion of the apertural face of the ultimate chamber, bordered by thin projections on either side of the slit.

Discussion.—*Lenticulina cultrata* differs from *L. rotulata* (Lamarck, 1804) in its more well-developed peripheral keel.

Distribution.—*Lenticulina cultrata* was described from the Tertiary of Italy. It is reported from the Holocene of the Atlantic, Pacific and Caribbean; Pleistocene of the Gulf of Mexico; late Miocene to early Pliocene (Bowden Formation) of Jamaica; as *L. iota* from the early Miocene (Ponce Formation) of Puerto Rico; and the Tertiary of the Dominican Republic and Mallorca. *Lenticulina cultrata* is rare at most localities in the Concepcion and Encanto "biozones" of the study area.

Lenticulina cf. **L. falcifer** (Stache, 1865)
Plate 10, figure 8

Cristellaria (*Cristellaria*) *falcifer* Stache, 1865, p. 240, pl. 23, figs. 19a–b.

Description.—Test free, planispiral, involute, biconvex in edge view, circular in side view; periphery acute with well-developed keel; seven to nine chambers in the last whorl, increasing fairly rapidly in size as added; apertural face of ultimate chamber flat; sutures distinct, limbate, early sutures raised, last two flush with surface, curved, converging in the umbilical area; wall calcareous, hyaline, smooth, finely perforate; aperture radiate, at peripheral angle with a robuline slit having distinct raised borders extending down the apertural face of the ultimate chamber.

Discussion.—The Mexican specimens are similar to *L. falcifer* but have a better-developed keel and broader apertural face than shown in the original figure.

Distribution.—This species is rare in the study area and only occurs at localities SD-4 and PD-56 in the Encanto "biozone".

Lenticulina formosa (Cushman, 1923)
Plate 10, figure 9

Cristellaria formosa Cushman, 1923, p. 110, pl. 29, fig. 1, pl. 30, fig. 6.
Lenticulina formosa (Cushman). Hadley, 1934, p. 11, pl. 1, fig. 11; Barker, 1960, p. 146, pl. 70, figs. 13, 14, 15.
Robulus formosus (Cushman). Bermudez, 1949, p. 126, pl. 6, figs. 57, 58; Becker and Dusenbury, 1958, p. 13, pl. 2, fig. 16.
Lenticulina brevispinosa (Nuttall). Todd and Low, 1976, p. 23, pl. 2, figs. 7a–b (not *Cristellaria brevispinosa* Nuttall, 1928).

Description.—Test free, large, planispiral, involute, compressed, biumbonate; periphery with a thin keel and flattened spines; eight to 12 chambers in the final whorl, increasing gradually in size as added; sutures distinct, slightly limbate, flush with surface, strongly curved, converging in the opaque umbo area; wall calcareous, hyaline, smooth, finely perforate; peripheral keel with flat spinelike processes at an oblique angle; aperture radiate at peripheral angle of the flat apertural face.

Discussion.—*Lenticulina formosa* has flat spinelike processes projecting from the thin keel, in contrast to the well-defined radial spines that project from the keel of *L. calcar* (Linnaeus, 1758). *Lenticulina formosa* differs from *Lenticulina brevispinosa* (Nuttall, 1928) from the Tertiary of Trinidad, in not possessing raised sutures.

Distribution.—*Lenticulina formosa* was described from the Holocene of the Caribbean. This species has been recorded from the Holocene of the Atlantic and Pacific; late Miocene to early Pliocene (Bowden Formation) of Jamaica; middle to late Miocene (Cojimar Formation) of Cuba; Tertiary of Colombia, Dominican Republic, and Puerto Rico. It is rare in the study area and only occurs at locality PD-43 in the lower Concepcion "biozone" and locality PD-52 in the Encanto "biozone".

Lenticulina peregrina (Schwager, 1866)
Plate 10, figures 10–11; Plate 11, figure 1

Cristellaria peregrina Schwager, 1866, p. 245, pl. 7, fig. 89; Cushman, 1923, p. 113, pl. 30, figs. 3, 4.
Cristellaria variabilis Reuss. Cushman, 1913, p. 70, pl. 36, figs. 1–3 (not *C. variabilis* Reuss, 1850).
Robulus variabilis (Reuss). Colom, 1946a, p. 137, pl. 6, figs. 88–89 (not *Cristellaria variabilis* Reuss, 1850).
Lenticulina peregrina (Schwager). Agip Mineraria, 1957, pl. 11, fig. 2; Barker, 1960, p. 144, pl. 68, figs. 11–16; Andersen, 1961, p. 46, pl. 10, figs. 7a–b; Akers and Dorman, 1964, p. 41, pl. 5, figs. 8, 9; Murray, 1971, p. 89, pl. 35, figs. 3–5.
Neolenticulina chathamensis McCulloch, 1977, p. 8, pl. 94, figs. 11–12.

Description.—Test free, planispiral, involute, biconvex, somewhat compressed, with thin peripheral keel; four to five chambers in the final whorl, increasing gradually in size as added, last few becoming inflated and tending to uncoil; sutures distinct, slightly curved, depressed between the last few inflated chambers; wall calcareous, hyaline, finely perforate, smooth; adult with a thin keel, which is more developed around ultimate chamber; aperture in adult specimen terminal, a cluster of hollow tubes, projecting above the keel, penultimate chamber with a radiate aperture.

Discussion.—This species has been commonly referred to *Lenticulina variabilis* (Reuss, 1850) by Cushman (1913) and others. *Lenticulina peregrina* (Schwager) is distinct from *L. variabilis* Reuss, as shown by the type figure and description. The type figure of *L. peregrina* (Schwager) illustrates the thin keel and the unusual fimbriate development of the aperture.

Cushman (1913), Barker (1960), and Murray (1971) show a difference between the juvenile *L. peregrina* and the adult form. The juvenile specimens have a thicker keel and a typical radiate aperture: the adult specimens have a much thinner keel and a complex, projecting, tubular aperture. This relationship has also been observed in the study material (see Pl. 10, figs. 10d, 11).

Distribution.—*Lenticulina peregrina* was described from the Pliocene of Car Nicobar. It is recorded from the Holocene of the Pacific, Atlantic, Gulf of Mexico, and Caribbean; Pleistocene of the Gulf Coast; Tertiary of Haiti, Mallorca, and Italy. This species occurs in low frequencies at most localities in the Concepcion and Encanto "biozones".

Genus **PALMULA** Lea, 1833

Palmula tenuistriata Bermudez, 1949
Plate 11, figure 2

Palmula borroi Bermudez var. *tenuistriata* Bermudez, 1949, p. 157, pl. 10, fig. 20.

Description.—Test free, flattened, elongate, early portion planispirally coiled, later becoming uncoiled and rectilinear; peripheral margin rounded; seven to eight chambers in the planispiral portion, increasing gradually in size, six to seven chevron-shaped chambers in the rectilinear portion, increasing rapidly in width, then increasing in size gradually; sutures indistinct in the planispiral portion, limbate and flush with surface and then slightly raised in the rectilinear portion; wall calcareous, hyaline, perforate, ornamented by delicate longitudinal costae that are most distinct on the coiled chambers and gradually disappear toward the apertural end; aperture terminal, radiate.

Discussion.—*Palmula tenuistriata* differs from *P. borroi* Bermudez, 1949, in having fewer chambers and a surface ornamented by fine longitudinal costae.

Distribution.—This species was described from the middle Pliocene (Mao Formation) of the Dominican Republic. It is rare at locality SD-4 in the Encanto "biozone".

Genus **SARACENARIA** Defrance, *in* Blaineville, 1824

Saracenaria italica Defrance, 1824
Plate 11, figures 3–4

Saracenaria italica Defrance, *in* Blaineville, 1824, p. 176, pl. 13, fig. 6; LeRoy, 1941b (part), p. 76, pl. 7, figs. 21–22 (not figs. 23–24); Dieci, 1959, p. 46, pl. 4, fig. 3; Barker, 1960, p. 144, pl. 68, figs. 17, 18, 20–23; Akers and Dorman, 1964, p. 52, pl. 6, figs. 20–22; Todd and Low, 1976, p. 24, pl. 3, figs. 8a–b.

Cristellaria italica (Defrance). Cushman, 1923, p. 125, pl. 35, figs. 2, 5–7.

Saracenaria italica Defrance var. *carapitana* Franklin. Becker and Dusenbury, 1958, p. 22, pl. 2, figs. 14a–b (not *Saracenaria carapitana* Franklin, 1944).

Description.—Test free, large, initial portion closely coiled, planispiral, evolute, later portion uncoiling and flaring, periphery subangular, triangular in transverse section, with broad, flat, apertural face; chambers slightly inflated, nine to ten chambers in the adult, rapidly increasing in size as added, later chambers not extending back to earlier volutions; sutures distinct, gently curved, slightly depressed in ventral view and inner margin of coil; wall calcareous, hyaline, smooth, finely perforate; aperture radiate, at peripheral angle.

Discussion.—*Saracenaria latifrons* (Brady, 1884) differs from *S. italica* in its smaller size and rounded lateral edges.

Distribution.—*Saracenaria italica* was described from the Tertiary of Italy. It is recorded from the Holocene of the Atlantic, Pacific, and Caribbean; Pleistocene of the Gulf Coast; Miocene of Siberoet Island, East Indies; Neogene of Colombia, Puerto Rico, Italy, and Okinawa. This species is rare in the Concepcion and Encanto "biozones".

Saracenaria latifrons (Brady, 1884)
Plate 11, figures 5–6

Cristellaria latifrons Brady, 1884, p. 544, pl. 68, fig. 19, pl. 113, figs. 11a–b.

Saracenaria latifrons (Brady). Renz, 1948, p. 162, pl. 5, fig. 22; Bermudez, 1949, p. 154, pl. 8, figs. 57–58; Asano, 1951, p. 13, text-figs. 67–68; Asano, 1956, p. 8, pl. 3, fig. 19; LeRoy, 1964, p. 25, pl. 3, fig. 36.

Description.—Test free, planispiral; initial portion closely coiled and compressed, involute; later portion uncoiling and flaring, dorsal margin angular, lateral edges rounded, triangular in transverse section, ventral face broad, widest near middle and tapering toward the aperture; ten to 12 chambers in the adult, increasing fairly rapidly in size as added, early chambers closely coiled, later becoming long and narrow, the last four chambers making up two-thirds of the test and extending well back towards the preceding whorl; sutures distinct, flush with surface, curved; wall calcareous, hyaline, finely perforate, smooth; aperture terminal, radiate.

Discussion.—The Mexican specimens are similar to those figured by Brady (1884, pl. 68, fig. 19), which show rounded lateral edges of the ventral face.

Saracenaria akitaensis Iwasa and Kikuchi, 1954, from the Miocene of Japan, is similar but has fewer chambers (eight in the adult) and a less carinate dorsal margin.

Distribution.—*Saracenaria latifrons* was described from the Holocene of the Atlantic and Pacific. It is recorded from the Pliocene of Japan, middle to late Miocene (Pozon Formation) of Venezuela, late Miocene to early Pliocene (Gurabo Formation) of the Dominican Republic, and the Neogene (Shimajiri Formation) of Okinawa. *Saracenaria latifrons* occurs in low frequencies in the Concepcion and Encanto "biozones".

Saracenaria nuttalli
Sansores and Flores-Covarrubias, 1972
Plate 11, figure 7

Saracenaria nuttalli Sansores and Flores-Covarrubias, 1972a, p. 79, pl. 1, figs. 8–9.

Description.—Test free, initial portion planispiral, evolute, later portion uncoiling and flaring, triangular in transverse section, with broad, flat apertural face; periphery keeled; nine to 11 chambers in the adult, the first five to six compressed, increasing gradually in size, the later chambers increasing rapidly in size and triangular in section; sutures distinct, limbate, raised, slightly curved; wall calcareous, hyaline, smooth, finely perforate; aperture terminal at peripheral angle, radiate; one of the slits enlarged with a lip on the ventral side.

Discussion.—*Saracenaria nuttalli* differs from *Saracenaria italica* Defrance var. *carapitana* Franklin, 1944, in possessing raised, limbate sutures and more flaring adult chambers.

Distribution.—*Saracenaria nuttalli* was described from the lower Concepcion Formation [*sic*] from a well on the continental shelf near Coatzacoalcos, Veracruz. It is restricted to the upper and lower Concepcion "biozones".

Saracenaria toddae Bermudez, 1949
Plate 11, figure 8

Saracenaria cushmani Palmer, 1945, p. 38, pl. 1, fig. 5 (homonym of *S. cushmani* Tappan, 1940).
Saracenaria toddae Bermudez, 1949 (*nom. nov.*), p. 154, pl. 9, figs. 3–6.

Description.—Test free, initial portion closely coiled and compressed, planispiral, evolute, later portion uncoiling and flaring, periphery keeled, triangular in transverse section, with broad, flat, apertural face; nine to 12 chambers in the adult, the initial six to nine compressed, increasing gradually in size, later chambers increasing rapidly in size, triangular in section; sutures distinct, with round knoblike beads on the sutures of the compressed portion, the sutures of the latter portion of the test with irregular elongate projections oriented parallel to the axis of coiling; wall calcareous, hyaline, smooth, finely perforate; aperture terminal, radiate, at end of elongate projection of ultimate chamber, with distinct neck.

Discussion.—The radiate aperture of *Saracenaria toddae* Bermudez may be a form intermediate between a more typical radiate pattern of diverging slits and that of *Cribrolenticulina* Haman, 1978, which has a cribrate pattern. Specimens of *S. toddae,* from the study area, have an aperture composed of irregular, sinuous, radiate slits that appear to be formed by the dissolution of the calcite connecting a series of radially-oriented circular openings. The outer edges of the radiate slits sometimes have one or two well-formed openings in alignment.

Saracenaria palmerae Cushman and Todd, 1945 differs from *S. toddae* in the finely-beaded wall of the early chambers and in possessing limbate and raised later sutures.

Distribution.—*Saracenaria toddae* was described from the late Miocene to early Pliocene (Bowden Formation) of Jamaica. It is also reported from the late Miocene to early Pliocene (Gurabo Formation) of the Dominican Republic. This species is rare in the upper Concepcion "biozone" at localities SD-21, PD-63 and 66.

Subfamily **MARGINULININAE** Wedekind, 1937

Genus **MARGINULINA** d'Orbigny, 1826

Marginulina glabra d'Orbigny, 1826
Plate 12, figures 1–2

Marginulina glabra d'Orbigny, 1826, p. 259, Modele no. 55; Cushman, 1923 (part), p. 127, pl. 36, fig. 6 (not fig. 5); Akers and Dorman, 1964, p. 43, pl. 5, fig. 10; Todd and Low, 1976, p. 23, pl. 3, figs. 3a–b.
Marginulina schlonbachi (Reuss). Boltovskoy, 1959, p. 63, pl. 8, fig. 2 (not Reuss, 1863).

Description.—Test free, elongate, initial portion slightly planispirally coiled, later portion uniserial, ovate in transverse section; periphery broadly rounded; seven to eight chambers in the adult, slightly inflated, slightly overlapping, first few increasing rapidly in size, later chambers increasing gradually in size; sutures distinct, oblique; wall smooth, calcareous, finely perforate; aperture terminal, radiate, near dorsal edge of ultimate chamber.

Discussion.—Marginulina glabra differs from *M. obesa* Cushman, 1923, in having an ovate instead of circular transverse section, and less embracing chambers. Many of the occurrences of *M. glabra* cited in the literature are actually *M. obesa.*

Distribution.—Marginulina glabra was described from the Tertiary of Italy. It is reported from the Holocene of the Atlantic, Pleistocene of the Gulf Coast; and Tertiary of Puerto Rico. It is rare in the Concepcion and Encanto "biozones".

Marginulina obesa Cushman, 1923
Plate 12, figure 3

Marginulina glabra d'Orbigny. Cushman, 1913, p. 79, pl. 23, fig. 3; Cushman and McCulloch, 1950 (part), p. 308, pl. 40, fig. 6 (not figs. 7, 8) (not d'Orbigny, 1826).

Marginulina glabra d'Orbigny var. *obesa* Cushman, 1923, p. 128, pl. 37, fig. 1

Marginulina subbullata Hantken. Renz, 1948, p. 145, pl. 4, figs. 13–15 (not Hantken, 1875).

Marginulina obesa Cushman. Barker, 1960, p. 136, pl. 65, figs. 5, 6; LeRoy and Levinson, 1974, p. 8, pl. 4, figs. 3–4.

Description.—Test free, elongate, initial portion slightly coiled, latter portion rectilinear, circular in transverse section; periphery broadly rounded; chambers inflated, five to six in the adult, strongly embracing, early chambers obscured by overlapping of later chambers; sutures indistinct, slightly depressed on last few chambers, somewhat oblique; wall calcareous, smooth, finely perforate; aperture radiate, with a short neck, near dorsal edge of ultimate chamber.

Discussion.—Marginulina obesa differs from *M. glabra* d'Orbigny, 1826, in its smaller length-to-width ratio and more embracing chambers.

Distribution.—Marginulina obesa was described from the Holocene of the Atlantic. It is recorded from the Holocene of the Pacific; Pleistocene of the Gulf of Mexico. It is rare in the Concepcion and Encanto "biozones".

Genus **MARGINULINOPSIS** Silvestri, 1904

Marginulinopsis goajiraensis
Becker and Dusenbury, 1958
Plate 12, figure 4

Marginulinopsis goajiraensis Becker and Dusenbury, 1958, p. 17, pl. 1, fig. 23; Sansores and Flores-Covarrubias, 1972b, p. 142, text-fig. 2

Description.—Test free, elongate, early portion a planispiral coil, compressed, later portion uncoiling, circular in transverse section; periphery of early coiled portion angular, uncoiled portion rounded and lobate; 12 to 15 chambers in the microspheric form, eight to ten in the megalospheric form, early coiled portion compressed, three to four inflated chambers in the uncoiled portion; sutures slightly raised and curved on coiled portion, flush or depressed on uncoiled portion; wall smooth, calcareous, finely perforate; aperture terminal, radiate, on a short projecting neck.

Discussion.—This species commonly occurs with *M. hispaniolana* (Bermudez, 1949) and differs in possessing a smooth rather than spinose surface.

Distribution.—Marginulinopsis goajiraensis was described from the Tertiary of the Goajira Peninsula, Colombia. It was also recorded from the lower Concepcion Formation [*sic*] from a well in Veracruz. This species is rare at most localities in the lower Concepcion and Encanto "biozones".

Marginulinopsis hispaniolana (Bermudez, 1949)
Plate 12, figure 5

Marginulina hispaniolana Bermudez, 1949, p. 140, pl. 9, figs. 32–33.

Marginulinopsis (?) *aculeata* (Neugeboren). Bermudez and Fuenmayor, 1966, p. 527, pl. 3, fig. 17 (not *Marginulina aculeata* Neugeboren, 1851).

Description.—Test free, elongate, early portion a compressed planispiral coil, later portion uncoiling, circular in transverse section; periphery of early coiled portion angular, uncoiled portion rounded and lobate; seven to ten chambers in the adult, increasing fairly rapidly in size, uncoiled portion with three to four inflated chambers, coiled portion with chambers compressed; sutures raised and beaded in the coiled portion, depressed in the uncoiled portion, wall calcareous, finely perforate, ornamented with acute spines randomly arranged on the uncoiled portion, mainly on the raised sutures in the coiled portion; aperture terminal, radiate, at end of short neck.

Discussion.—Within a population of *M. hispaniolana* there is variation in the amount of spinose ornamentation. The variability occurs mostly in the coiled portion: on some individuals the surface is entirely smooth, and on others ornamented with raised spinose sutures.

Marginulinopsis aculeata (Neugeboren, 1851) differs from *M. hispaniolana* in possessing only four to five chambers with more pronounced spines on the early chambers.

Distribution.—Marginulinopsis hispaniolana was described from the late Miocene to early Pliocene (Gurabo Formation) of the Dominican Republic. It is also reported from the middle to late Miocene (Cubagua Formation) of Venezuela. This species is rare in the lower Concepcion and Encanto "biozones" of the study area.

Marginulinopsis nana (Costa, 1894)
Plate 12, figure 6

Marginulina nana Costa, *in* Fornasini, 1894, p. 218, pl. 2, fig. 16.
Marginulina hirsuta d'Orbigny. Verdenius, 1970, p. 78, pl. 3, fig. 5 (not d'Orbigny, 1846).

Description.—Test free, elongate, early portion compressed, planispiral, later portion uncoiling, circular in transverse section; periphery of coiled portion angular with a distinct keel, uncoiled portion rounded and lobate; chambers distinct, six to eight compressed chambers in the coiled portion, two to three in the uncoiled portion, inflated, gradually increasing in size; sutures beaded in the coiled portion; wall calcareous, finely perforate, ornamented with distinct beads between the sutures in the coiled portion, beads grading into smaller spines randomly spaced in the uncoiled portion, area around the aperture smooth, some spines on the peripheral keel; aperture terminal, at end of a short neck, radiate with nine to ten slits, the one facing the ventral side larger, with a pronounced lip.

Discussion.—*Marginulinopsis subaculeata* (Cushman, 1923) differs from *M. nana* (Costa) in possessing a truncate apertural face and non-inflated chambers in the uncoiled portion.

Distribution.—*Marginulinopsis nana* was described from the Tertiary of Sicily. It is also recorded as *Marginulina hirsuta* from the Ecija Formation of southern Spain. *Marginulinopsis nana* is rare in the Concepcion and Encanto "biozones".

Subfamily **VAGINULININAE** Reuss, 1860b

Genus **VAGINULINA** d'Orbigny, 1826

Vaginulina alazanensis Nuttall, 1932
Plate 12, figures 7–9

Vaginulina alazanensis Nuttall, 1932, p. 17, pl. 1, figs. 11, 15; Renz, 1948, p. 176, pl. 5, figs. 25a–b.
Vaginulina sp. cf. *V. clavata* Costa. Becker and Dusenbury, 1958, p. 22, pl. 2, fig. 11 (not *Vaginulina clavata* Costa, 1855).

Description.—Test free, elongate, length five to seven times the width, gently curved, compressed, ovate in transverse section, periphery rounded; chambers distinct, eight to ten in the adult, increasing in size gradually, proloculus bulbous, much larger than next chamber; sutures distinct, limbate, oblique, width of sutures increasing toward inner margin of test; wall calcareous, hyaline, smooth; aperture eccentric, slightly produced at inner margin of ultimate chamber, radiate.

Discussion.—*Vaginulina pseudoclavata* Colom, 1943, from the Neogene of the Balearic Isles (Mediterranean Sea), differs from *V. alazanensis* in its much larger size and greater number of chambers.

Distribution.—*Vaginulina alazanensis* was described from the late Oligocene (Alazan Formation), Mexico. It is recorded from the middle to late Miocene (Pozon Formation) and early Miocene (San Lorenzo Formation) of Venezuela; and the middle to late Miocene (Cojimar Formation) of Cuba. It is rare in the Concepcion and Encanto "biozones".

Family **POLYMORPHINIDAE** d'Orbigny, *in* Sagra, 1839

Subfamily **POLYMORPHININAE** d'Orbigny, 1839b

Genus **GLOBULINA** d'Orbigny, *in* Sagra, 1839

Globulina species
Plate 13, figure 1

Description.—Test ovate in side view, slightly compressed in transverse section, base rounded, slightly tapering toward apertural end, with 12 or more conical tubular growths concentrated on the upper portion of the test but with few on the lower half; chambers few, inflated, globular, strongly overlapping, five chambers added in two rotations of the test axis; sutures indistinct; wall calcareous, hyaline, finely perforate, ornamented with numerous small spines that also cover the lower portions of the tubular growths; primary aperture obscured by the fistulose growths, many of which are hollow.

Discussion.—This form closely resembles individuals assigned by Colom (1946b, pl. 13, figs. 266, 267) to *Globulina gibba* d'Orbigny, 1826, forma *fistulosa* from the Neogene of Mallorca.

Distribution.—*Globulina* sp. occurs only at locality PD-45 in the lower Concepcion "biozone" of the study area.

Genus **GUTTULINA** d'Orbigny, *in* Sagra, 1839

Guttulina cf. **G. sadoensis** (Cushman and Ozawa, 1928)
Plate 13, figure 4

Sigmomorphina sadoensis Cushman and Ozawa, 1928, p. 17, pl. 2, fig. 11.

Description.—Test free, more or less rhomboid in front view, greatest width below the middle, ovate to slightly triangular in transverse section; chambers elongate, two to three times as long as broad, overlapping, inflated, added in quinqueloculine series approximately 144° apart, each successive chamber extending further from the base; sutures depressed, distinct; wall calcareous, hyaline, smooth, finely perforate; aperture terminal, slightly produced, a single row of circular to ovate openings oriented in the plane of compression, surrounded by elongate openings forming a complex cribrate aperture.

Discussion.—*Guttulina sadoensis* (Cushman and Ozawa, 1928) was described from the Pliocene Sawane Formation of Japan. *Guttulina* cf. *G. sadoensis* from the study area differs in its less triangular cross-section and in possessing a cribrate aperture.

Loeblich and Tappan (1964a, p. C530) state that all genera within the family Polymorphinidae have radiate apertures. Poag (1969) erected a new subfamily, Vasiglobulinae, for forms with hollow tubules instead of diverging slits.

Poag (1969, p. 69) concluded that "several apertural systems occur within the Polymorphinidae in addition to the vasiglobuline and radiating slit types." He suggested a thorough re-examination of the type species of genera assigned to the Polymorphinidae.

The specimen figured in Plate 13, figure 4, shows a cribrate apertural system. Additional studies of genera within the subfamily Polymorphininae are needed to determine the variation of apertural development.

Distribution.—*Guttulina* cf. *G. sadoensis* is rare at localities SD-4 and PD-37 in the Encanto "biozone".

Genus **PARADENTALINA** Uchio, 1960

Paradentalina muraii (Uchio, 1953)
Plate 13, figure 5

Enantiodentalina muraii Uchio, 1953, p. 152, pl. 14, figs. 1–2.
Paradentalina muraii (Uchio). Uchio, 1960, p. 60, pl. 4, fig. 2.
Enantiodentalina communis (d'Orbigny). Andersen, 1961, p. 80, pl. 17, figs. 1a–b (not *Nodosaria communis* d'Orbigny, 1826).

Description.—Test free, elongate, slightly curved, subcylindrical; chambers alternating in early portion of test, later uniserial, generally higher than wide; chambers gradually increasing in size in uniserial portion, each chamber closely embracing the previous one, the alternating portion of test small, comprising one-quarter the total test length; sutures oblique, depressed; wall calcareous, smooth, finely perforate; aperture terminal, radiate, projecting.

Discussion.—Uchio (1960) proposed *Paradentalina* for forms assigned to *Enantiodentalina* Marie, 1941, having an early biserial stage later becoming uniserial. *Paradentalina muraii* (Uchio, 1953) was designated as the type species for *Paradentalina.*

Distribution.—*Paradentalina muraii* (Uchio, 1953) is reported from the Holocene of California, Pleistocene of the Gulf Coast, and Plio-Pleistocene of Japan. This species is rare in the study area and occurs only at locality SD-4 in the Encanto "biozone".

Genus **SIGMOMORPHINA**
Cushman and Ozawa, 1928

Sigmomorphina species A
Plate 13, figure 3

Description.—Test free, compressed, circular to ovate in side view, broadest across the middle, about as high as broad, periphery rounded; chambers inflated, slightly compressed, embracing, added in a sigmoidal series in planes slightly less than 180° apart; each chamber added farther from the base, strongly overhanging at edge of test; sutures not depressed; wall calcareous, hyaline, smooth, finely perforate; aperture radiate, terminal, a series of slits almost perpendicular to the plane of compression.

Distribution.—*Sigmomorphina* sp. A is rare at localities PD-63 and 40 in the upper Concepcion "biozone" and locality SD-4 in Encanto "biozone" of the study area.

Genus **VASIGLOBULINA** Poag, 1969

Vasiglobulina species
Plate 13, figure 2

Description.—Test ovoid to pyriform in side view, circular to slightly compressed in transverse section, base rounded, outline tapering to apertural end; chambers few, inflated, embracing, rapidly increasing in size, added in a spiral coil at approximately 144° apart; sutures indistinct; wall calcareous, hyaline, finely perforate, surface ornamented by small spines randomly arranged; aperture a series of six or more hollow tubules radiating outward at the distal end of the ultimate chamber.

Discussion.—The genus *Vasiglobulina* Poag, 1969, was erected to include all "polymorphic species which possess an apertural system of hollow tubercles radiating outward from the distal end of the final chamber lumen to the exterior surface of the test" (Poag, 1969, p. 45). *Vasiglobulina alabamensis* (Cushman and McGlamery, 1939), from the Oligocene of the Gulf Coast, was selected as the type species. Poag's excellent restudy of species assigned to *Globulina* d'Orbigny, 1839a, revealed that many of the spinose forms did not have a radiate aperture but possessed the hollow tubules of *Vasiglobulina.*

Vasiglobulina sp. differs from *V. alabamensis* Cushman and McGlamery, 1939, in its more lobate outline in side view, less circular cross-section and its lack of long attachment spines that penetrate carbonate substrate.

Distribution.—Poag (1969) determined that *Vasiglobulina* ranged from late Eocene to Pliocene. Poag (1982) documented living forms of *Vasiglobulina* from the western North Atlantic. *Vasiglobulina* sp. is rare in the study area, only occurring at locality SD-4 in the Encanto "biozone".

Subfamily **RAMULININAE** Brady, 1884

Genus **RAMULINA** Jones, *in* Wright, 1875

Ramulina globulifera Brady, 1879
Plate 14, figure 1

Ramulina globulifera Brady, 1879, p. 272, pl. 8, figs. 32–33; Cushman, 1913, p. 110, pl. 39, fig. 1; Colom, 1946a, p. 152, pl. 13, figs. 266, 267; Bermudez, 1949, p. 164, pl. 11, figs. 10, 11; Agip Mineraria, 1957, pl. 20, fig. 8; Barker, 1960, p. 158, pl. 76, figs. 22–28; LeRoy and Hodgkinson, 1975, p. 436, pl. 8, fig. 10.

Description.—Test free, branching, composed of several globular segments of different sizes connected by stolonlike necks; chambers globular to subglobular, of unequal size; wall calcareous, hyaline, finely perforate, ornamented by short spines; apertures tubular, often three to four to a single chamber, circular to ovate in cross-section.

Discussion.—This form is very fragile and only broken specimens with a single chamber occur in the Mexican material. Poag (written commun., 1982) states that he believes that *R. globulifera* is a segment of fistulose growth from a polymorphid.

Distribution.—*Ramulina globulifera* was described from the Holocene of the North Atlantic and South Pacific. It is recorded from the Holocene and Pleistocene of the Gulf of Mexico, Tertiary of Italy and Mallorca, late Miocene to early Pliocene (Gurabo Formation) of the Dominican Republic, and the Neogene (Shimajiri Formation) of Okinawa. This species is rare, only occurring at locality SD-4 in the Encanto "biozone" of the study area.

Family **GLANDULINIDAE** Reuss, 1860b

Subfamily **GLANDULININAE** Reuss, 1860b

Genus **ENTOLINGULINA**
Loeblich and Tappan, 1961

Entolingulina alazanensis (Nuttall, 1932)
Plate 14, figure 3

Frondicularia alazanensis Nuttall, 1932, p. 17, pl. 3, fig. 15, pl. 4, fig. 1; Cushman and Ellisor, 1945, p. 558, pl. 74, fig. 11.

Entolingulina alazanensis (Nuttall). Todd and Low, 1976, p. 22, pl. 2, figs. 14–15.

Description.—Test free, compressed, uniserial, length one-and-one-half times the width, periphery rounded; chambers inflated, three in the adult, proloculus large, inflated, circular in side view; last two chambers inflated, strongly embracing, semicircular in side view, the sides of each chamber extending downward to envelop the previous one, continuing to the proloculus; sutures depressed, strongly curved; wall calcareous, hyaline, smooth, finely perforate; aperture terminal, a distinct, elongate slit in plane of compression, with a raised rim.

Discussion.—The specimens from this study are similar to the form figured by Nuttall (1932, pl. 3, fig. 15). Nuttall's specimen has four chambers and is probably a juvenile.

Distribution.—*Entolingulina alazanensis* was described from the late Oligocene (Alazan Formation) of Mexico. It is also recorded from the Oligocene (Anahuac Formation) of Texas, and from the Oligo-Miocene (Juana Diaz Formation) of Puerto Rico. This species is rare in the study area, only occurring at locality SD-4 in the Encanto "biozone", and is probably reworked from older strata.

Genus **GLANDULINA** d'Orbigny, *in* Sagra, 1839

Glandulina laevigata d'Orbigny, 1826
Plate 14, figure 2

Nodosaria (*Glanduline*) *laevigata* d'Orbigny, 1826, p. 252, pl. 10, figs. 1–3.

Glandulina laevigata d'Orbigny. Cushman and Ozawa, 1930, p. 143, pl. 40, figs. 1a–b; Cushman, 1933c, p. 41, pl. 9, figs. 14a–b; Cushman and Todd, 1945, p. 34, pl. 5, fig. 19; Colom, 1946a, p. 75, pl. 10, fig. 325; Loeblich and Tappan, 1953, p. 81, pl. 16, figs. 2–5; Agip Mineraria, 1957, pl. 20, fig. 7; Becker and Dusenbury, 1958, p. 25, pl. 3, fig. 23.

Rectoglandulina laevigata (d'Orbigny). LeRoy, 1964, p. 23, pl. 14, figs. 29, 30.

Description.—Test free, ovate in outline, fusiform, length one-and-one-half times the width, circular in transverse section, pointed at the base; early portion biserial, later uniserial; chambers strongly overlapping and rapidly increasing in size, ultimate chamber comprising one-half to two-thirds the length of the test; sutures distinct, not depressed; wall calcareous, hyaline, finely perforate, smooth, opaque, except for the area near the aperture, which is translucent; aperture terminal, radiate, 18 to 20 elongate slits between ribs radiating from a slight depression, with a short entosolenian tube.

Discussion.—According to Cushman (1930, p. 143), the microspheric form is initially biserial then abruptly becomes uniserial, but the megalospheric form is uniserial throughout.

Distribution.—*Glandulina laevigata* was described from the Tertiary of Italy and the Holocene of the Adriatic Sea. It is recorded from the Holocene of the Pacific, Gulf of Mexico, Caribbean, and Arctic Ocean; Pleistocene of the Gulf Coast; Tertiary of Mallorca and Venezuela; late Miocene to early Pliocene (Bowden Formation) of Jamaica; and the Neogene (Shimajiri Formation) of Okinawa.

This species occurs in the upper and lower Concepcion "biozones", and the Encanto "biozone".

Subfamily **OOLININAE**
Loeblich and Tappan, 1961

Genus **FISSURINA** Reuss, 1850

Fissurina bodjonegoroensis (Boomgaart, 1950)
Plate 15, figure 1

Entosolenia sp. B LeRoy, 1941b, p. 80, pl. 1, figs. 35, 36.

Entosolenia iota Boomgaart, 1949, p. 109, pl. 11, figs. 7a–c [homonym of *Entosolenia iota* Cushman, 1923].

Entosolenia bodjonegoroensis Boomgaart, *in* Thalmann, 1950 (*nom. nov.*), p. 42.

Description.—Test free, unilocular, with short entosolenian tube, compressed, oval in transverse section, circular in side view, with a slightly-produced apertural end; wall calcareous, hyaline, smooth, center of test transparent with an opaque thickened area in shape of a horseshoe around the margin and up the sides, finely perforate, ornamented by the twin thickened rims that begin at the base of the test where they are joined, and continue as parallel thickened processes extending to the apertural end, with a furrow in between; aperture terminal, a thin slit between the swelling of the rims as seen in apertural view, slightly produced in side view.

Discussion.—The Mexican specimens differ somewhat from Boomgaart's type figure in possessing a thick, swollen area around the aperture as seen in apertural view (Pl. 15, fig. 1a).

Distribution.—*Fissurina bodjonegoroensis* was described from the Pliocene of Java. It has also been recorded from the Neogene of Borneo. This species is rare in the Encanto "biozone".

Fissurina fistulosa (Matthes, 1939)
Plate 15, figure 2

Lagena limbata Matthes var. *fistulosa* Matthes, 1939, p. 82, pl. 6, fig. 114.

Description.—Test free, small, unilocular, inflated, ovate in side view, slightly flattened in cross-section; wall calcareous, hyaline, finely perforate, ornamented by two bladelike costae on either side of test in plane of compression, connected at the base, extending along the test and continuing up the neck, nine to ten costae of lower relief and differing length on each side of test, some extending from the base and continuing along neck, others beginning near middle of test and extending to base of neck; aperture terminal, a round opening at the end of a short neck.

Discussion.—*Fissurina fistulosa* differs from *Fissurina limbata* (Matthes, 1939) in having a costate rather than smooth surface.

Matthes (1939) notes in his type description that *F. fistulosa* has a short, straight entosolenian tube. This feature could not be seen in the Mexican specimens.

Distribution.—This species was described from the Miocene of Germany. It is rare in the study area and occurs only at locality SD-4 in the Encanto "biozone".

Fissurina lucida (Williamson, 1848)
Plate 15, figures 3–4

Entosolenia marginata (Montagu) var. *lucida* Williamson, 1848, p. 17, pl. 2, fig. 17.

Entosolenia lucida Williamson. Cushman and Gray, 1946, p. 30, pl. 5, figs. 16–18; Asano, 1951, p. 35, fig. 153.

Fissurina lucida (Williamson). Loeblich and Tappan, 1953, p. 76, pl. 14, fig. 4; Todd and Low, 1967, p. 28, pl. 3, fig. 31; Murray, 1971, p. 97, pl. 39, figs. 1–3.

Description.—Test free, unilocular, somewhat compressed, ovate in side view, margin rounded without a keel, base smooth and rounded; wall calcareous, hyaline, finely perforate, with a horseshoe-shaped opaque band in side view, open toward the apertural end; aperture terminal, a slit in the plane of compression on the bluntly pointed anterior end, with short entosolenian tube.

Discussion.—This species is characterized by the opaque horseshoe-shaped band with a clear central portion (shown in side view in Pl. 15, fig. 3). The Mexican specimens closely resemble the figure of Murray (1971, pl. 39, fig. 1).

Distribution.—*Fissurina lucida* was described from the Holocene of the British Isles. It has been recorded from the Holocene of the Atlantic and Pacific; Pleistocene of California; Tertiary of Japan and Jamaica. *Fissurina lucida* is rare in the lower Concepcion and Encanto "biozones".

Fissurina marginata (Montagu, 1803)
Plate 15, figure 5

Serpula (*Lagena*) *marginata* Walker and Boys, 1784, p. 2, pl. 1, fig. 7 [*nomen nudum*].

Vermiculum marginatum Montagu, 1803, p. 524 (refer to Walker and Boys, 1784, pl. 1, fig. 7).

Fissurina marginata (Walker and Boys) [*sic*]. Galloway and Heminway, 1941, p. 353, pl. 11, figs. 4a–b; Feyling-Hanssen, 1964, p. 315, pl. 15, fig. 22.

Entosolenia marginata (Montagu). Cushman and Gray, 1946 (part), p. 30, pl. 5, figs. 19, 20 (not figs. 21–24).

Entosolenia submarginata Boomgaart, 1949, p. 107, pl. 9, fig. 7; Barker, 1960, p. 124, pl. 59, figs. 21, 22.

Fissurina marginata (Montagu). Asano, 1956 (part), p. 53, pl. 5, figs. 59, 60 (not figs. 58, 61).

Description.—Test free, unilocular, with entosolenian tube, compressed, ovate in transverse section, periphery with a thin narrow keel, ovate in side view, with slightly produced apertural end; wall calcareous, hyaline, smooth, finely perforate; aperture terminal, at end of a thickened neck, elliptical, surrounded by a well-developed lip, keel continuing up the neck to merge with the lip.

Discussion.—Fissurina marginata has been accredited to Walker and Boys (1784), by many authors. Since Walker and Boys (1784) did not consistently apply the principles of binomial nomenclature, *Testacea Minuta Rariora* was placed on the Official Index of Rejected and Invalid Works in Zoological Nomenclature (ICZN, 1959, Opinion 558) and their specific names have been rejected. In 1803, Montagu described the form figured by Walker and Boys and it is valid as of that date.

Boomgaart (1949) introduced a new name for *Fissurina marginata* (Montagu), which he considered to be a junior secondary homonym for Walker and Boys' species. Since Walker and Boys' species is now invalid, *Fissurina submarginata* (Boomgaart, 1949) has become a junior synonym of *F. marginata* (Montagu).

Many forms have been included under the name *Fissurina marginata,* but in this study only narrowly-keeled individuals are included.

Distribution.—Fissurina marginata was described from the Holocene of the North Sea. It is recorded from the Holocene of the Pacific, Atlantic, and Arctic oceans; Pleistocene of Norway; Pliocene of California and Japan; and the early Miocene (Ponce Formation) of Puerto Rico. It is rare at localities PD-68 and 72, in the Encanto "biozone".

Fissurina millettii Todd, 1954

Plate 15, figure 6

Lagena cf. *marginato-perforata* (Seguenza). Cushman, 1930, p. 32, pl. 5, fig. 12.

Lagena marginato-perforata Seguenza. Cushman, 1933c (part), p. 19, pl. 5, figs. 1a–b, pl. 6, figs. 1a–b (not pl. 4, figs. 13a–b) (not Seguenza, 1880).

Fissurina millettii Todd, *in* Cushman, Todd, and Post, 1954, p. 351, pl. 87, fig. 30.

Description.—Test free, unilocular, small, ovate in side view, compressed, about twice as long as broad, widest near middle of test; base round in side view, with a distinct keel on the lower half of test, in plane of compression; wall calcareous, hyaline, smooth, coarsely perforate; aperture compressed, terminal, slightly produced, with a short flat neck and an everted lip attached to a thin keel on the uppermost portion of test.

Discussion.—Fissurina millettii differs from *F. marginato-perforata* (Seguenza, 1880) in its finer perforations, short neck with an everted lip, and less-developed keel.

Distribution.—This species was described from the Holocene of the Pacific. It is also recorded from the Miocene (Choctawhatchee Formation) of Florida. It is rare at locality PD-63 in the upper Concepcion "biozone".

Fissurina neptuni (Buchner, 1940)

Plate 15, figure 7

Lagena neptuni Buchner, 1940, p. 484, pl. 15, figs. 294–296.

Description.—Test free, unilocular, compressed, round to ovate in side view, with slightly produced apertural end; a thin keel extends around base of test, with three to five spines arranged symmetrically; wall calcareous, hyaline, finely perforate, smooth; aperture a narrow slit in the plane of compression, with a rim on each side, the rims extending down the edge of the test coalescing with the keel.

Discussion.—Fissurina neptuni differs from two similar species: *F. fasciata* (Egger) var. *spinosa* (Sidebottom, 1912) and *F. kerguelensis* Parr, 1950, in that *F. neptuni* has a bifurcating keel that forms a trough on each side of the test. From the original descriptions and figures, the other two species appear to have only a single keel, extending entirely around the periphery.

Distribution.—This species was described from the Holocene of the Mediterranean. It is found in low frequencies at most of the localities in the lower Concepcion and Encanto "biozones".

Fissurina schwageriana (Cushman, 1931)

Plate 15, figure 9

Lagena formosa Schwager, 1866 (part), p. 206, pl. 4, figs. 19b–c (not figs. 19a, d).

Lagena schwageriana Cushman, 1931, p. 26, pl. 4, fig. 2; Cushman, 1934, p. 118, pl. 13, figs. 14, 15, 17.

Lagena flintiana Cushman. Bermudez, 1949, p. 117, pl. 11, fig. 1 (not *Lagena flintiana* Cushman, 1923).

Description.—Test free, unilocular, large, with a central body and a broad peripheral keel, compressed, ovate in cross-section; body circular in side view; keel thin near base of test, thickening toward the apertural end and forming a broad hoodlike structure; wall calcareous, hyaline, smooth, finely perforate; aperture terminal, a narrow slit in the plane of compression.

Discussion.—Fissurina schwageriana is characterized by the broad thin peripheral keel and the broad hoodlike structure at the apertural end.

Distribution.—This species is recorded from the Pliocene of Car Nicobar, and the Fiji Islands; and the late Oligocene (Trinchera Formation) of the Dominican Republic. It is rare at locality PD-70 in the Encanto "biozone".

Genus **OOLINA** d'Orbigny, 1839b

Oolina sayulensis, new species

Plate 16, figure 1

Etymology of name.—Named for the town of Sayula in the State of Veracruz, Mexico (Text-fig. 6).

Description.—Test free, unilocular, small, elliptical in side view, length one-and-one-half times the width, apex pointed, circular in transverse section; base slightly flattened with spinose projections; wall calcareous, hyaline, finely perforate, ornamented by ten to 20 longitudinal, evenly-spaced costae on the lower two-thirds of test, originating near a circular area at the base, continuing as weak striae along the last one-third of test to base of collar; aperture terminal, a small round opening at the end of a short neck projecting from the collar, with an entosolenian tube projecting slightly into the chamber cavity.

Diagnosis.—*Oolina sayulensis* is distinguished by its smooth collar and non-costate upper one-third of test.

Discussion.—*Oolina acuticosta* (Reuss, 1862) differs from *O. sayulensis* in possessing only eight to 12 costae, which continue to the base of the neck.

Oolina borealis Loeblich and Tappan, 1954, differs from *Oolina sayulensis* in possessing costae that continue to the base of the smooth collar and a radiate aperture instead of a simple pore (see Loeblich and Tappan, 1953, p. 68).

Oolina apliopleura (Loeblich and Tappan, 1953), from the Holocene of Alaska, has fewer costae (ten to 12), which continue to the base of the collar. *Lagena asanoi* Matsunaga, 1963, from the Neogene of Japan, is similar to *O. apliopleura* (Loeblich and Tappan) but has more costae (20 to 24).

Types.—Holotype: USNM 400651; paratypes: USNM 400652.

Measurements.—Length: 0.32–0.45 mm, width: 0.23–0.27 mm. Holotype: length: 0.42 mm, width 0.27 mm.

Type locality.—Locality PD-45, Potrerillos Dome, south side of Mexican Highway #180, 12.1 km east of Acayucan, State of Veracruz, Mexico. In the lower Concepcion "biozone" (N.19), early Pliocene.

Other localities.—Rare in the Encanto "biozone" (locs. PD-68 and SD-4) of the study area.

Oolina cf. **O. alifera** (Reuss, 1870)
Plate 16, figure 2

Lagena alifera Reuss, 1870, p. 467, text-figs. 15–16, 21, 22.

Description.—Test free, unilocular, small (length: 0.3 mm), elliptical in side view, circular in transverse section; base slightly truncated; wall calcareous, hyaline, finely perforate, ornamented with five to six prominent longitudinal, bladelike costae, evenly spaced, originating at a ring at the base and merging into a smooth raised collar that is either pentagonal or hexagonal in apertural view; one to two costae intervening in position, varying in length and terminating below the collar; area below collar excavated in side view between the prominent costae; aperture terminal, a small round opening at the end of a short, smooth neck that projects from the collar, with a short entosolenian tube projecting slightly into the chamber cavity.

Discussion.—The specimens from this study closely resemble *O. alifera* (Reuss) described from the middle Oligocene of Germany. However, *O. alifera* has fewer costae (eight to nine) and a quadrate collar.

Oolina sayulensis, n. sp. differs from *O.* cf. *O. alifera* in possessing a circular collar and costae restricted to the lower two-thirds of test.

Distribution.—*Oolina* cf. *O. alifera* is rare at localities PD-37, 52, 56, 58, and SD-4 in the Encanto "biozone".

Oolina cellularis (Silvestri, 1896)
Plate 16, figure 3

Lagena cellularis Silvestri, 1896, p. 118, pl. 3, figs. 3a–b, 4.

Description.—Test free, unilocular, pyriform in side view, circular in cross-section, greatest width near middle of test, gradually tapering to a short stout neck; wall calcareous, hyaline, finely perforate, ornamented with a raised reticulate network of irregular pits covering the entire test except for the neck, which is smooth, and the small circular depression at the base of test; aperture terminal, a small round opening at the end of the neck.

Discussion.—*Oolina mariae* (Karrer, 1877) differs from *O. cellularis* in possessing the hexagonal cells in rows parallel to the long axis of the test. Silvestri (1896) shows rhombohedral cells in his type figure of *O. cellularis.* The Mexican specimens have irregularly-shaped pits. Since the species is rare in the study area, the variation of cellular pattern cannot be determined.

Distribution.—*Oolina cellularis* was described from the Pliocene of Italy. This species is rare in the Encanto "biozone" at locality SD-4.

Oolina hexagona (Williamson, 1848)
Plate 16, figure 4

Entosolenia squamosa (Montagu). var. γ, *hexagona* Williamson, 1848, p. 20, pl. 2, fig. 23.

Lagena hexagona (Williamson). Cushman, 1930, p. 30, pl. 5, figs. 11a–b; Marks, 1951, p. 46; Bermudez and Seiglie, 1963, p. 93, pl. 17, fig. 10.

Entosolenia hexagona Williamson. Asano, 1951, p. 35, fig. 151.

Oolina hexagona (Williamson). Akers and Dorman, 1964, p. 46, pl. 6, fig. 8; Murray, 1971, p. 93, figs. 1–3; Feyling-Hanssen *et al.*, 1971, p. 224, pl. 17, fig. 6.

Description.—Test free, unilocular, small, subglobular in side view, circular in cross-section, with a short thick neck; wall calcareous, hyaline, finely perforate, ornamented with a reticulate pattern of raised hexagonal cells arranged in a honeycomb pattern; aperture terminal, a small rounded opening slightly produced at the end of the polygonal shaped neck.

Discussion.—*Oolina hexagona* differs from *O. melo* d'Orbigny, 1839b, in its hexagonal rather than quadrangular cells.

Distribution.—*Oolina hexagona* is recorded from the Holocene of the Atlantic; Pleistocene, and Miocene of the Gulf Coastal Plain; Tertiary of California, Europe, Caribbean and Mediterranean. This species is rare in the Encanto "biozone" of the study area at localities PD-56 and 68.

Oolina melo d'Orbigny, 1839
Plate 16, figure 5

Oolina melo d'Orbigny, 1839b, p. 20, pl. 5, fig. 9; Asano, 1956, p. 43, pl. 5, figs. 44–50; Murray, 1971, p. 93, pl. 37, figs. 4–6; Feyling-Hanssen *et al.,* 1971, p. 226, pl. 6, fig. 5, pl. 17, fig. 9.
Entosolenia squamosa var. *catenulata* Williamson, 1848, p. 19, pl. 2, fig. 20.
Entosolenia squamosa var. *scalariformis* Williamson, 1848, p. 20, pl. 2, figs. 21–22.
Lagena catenulata (Williamson). Cushman, 1923, p. 9, pl. 1, fig. 11.
Entosolenia catenulata Williamson. Asano, 1951, p. 34, fig. 149.

Description.—Test free, small, unilocular, oval in side view, circular in cross-section, length one-and-one-half times the width, upper portion of test slightly tapering to the apertural end, which has a short broad neck; wall calcareous, hyaline, finely perforate, ornamented by 18 to 20 longitudinal costae that extend from the base to the apertural end; in between and perpendicular to the costae are eight to ten ridges forming raised rectangular cells; the cells formed at the base of test and those surrounding the aperture are polygonal; aperture terminal, a small round opening produced at the end of a short neck ornamented by costae, which in end view form a six- to eight-pointed star.

Discussion.—Loeblich and Tappan (1953, p. 72) noted in their studies of Recent Arctic foraminifers that the forms described as varieties *O. catenulata* and *O. scalariformis* by Williamson appear to be end members of a gradational series. These varieties were combined under the name *Oolina melo* d'Orbigny, 1839b. Asano (1956, p. 44), agreed that "there is a considerable amount of variation in the forms, but they seem to form a gradational series." Following this rationale, *O. scalariformis* and *O. catenulata* are placed in synonymy with *O. melo* in this study.

Marks (1951, p. 46) noted that the ornamentation of *O. hexagona* (Williamson, 1848) and *O. scalariformis* (Williamson, 1848) tend to intergrade. It may be possible with a detailed population study to show that *O. melo* sensu lato and *O. hexagona* are part of a continuous morphologic series.

Distribution.—*Oolina melo* is recorded from the Holocene of the Atlantic and Pacific, Pleistocene of the Gulf Coast and Denmark, and Tertiary of Europe and Japan. This species is rare in the Concepcion and Encanto "biozones".

Oolina setosa (Earland, 1934)
Plate 16, figure 6

Lagena longispina Brady, 1884 (part), p. 454, pl. 56, figs. 33–35 (not pl. 56, fig. 36 or pl. 59, figs. 13–14).
Lagena globosa (Montagu) var. *setosa* Earland, 1934, p.150, pl. 6, fig. 52.
Lagena distycha Buchner, 1940, p. 513, pl. 21, figs. 438–439.
Oolina globosa (Montagu) var. *setosa* (Earland). Barker, 1960, p. 116, pl. 56, figs. 33–35.
Oolina globosa (Montagu) var. *setesa* [*sic*] (Earland). LeRoy, 1964, p. 26, pl. 13, fig. 44.

Description.—Test free, unilocular, small, subcircular to ovate in side view, circular in cross-section; wall calcareous, hyaline, finely perforate; base ornamented with eight to ten well-developed spines, irregularly spaced, the remainder of test smooth; aperture terminal, a small elliptical opening, slightly produced.

Discussion.—Earland (1934) considered Brady's figures of *O. longispina* to represent two distinct forms. One form, with short basal spines irregularly spaced, he assigned to *O. globosa* (Montagu) var. *setosa* (Earland, 1934). The other form, with long spines on the base oriented in a row, he placed in *O. longispina* (Brady, 1884). Barker (1960, p. 116) agreed with this separation, and it is therefore utilized in this study.

Distribution.—*Oolina setosa* is recorded from the Holocene of the Pacific and Mediterranean; and Pliocene of Okinawa. This species is rare in the Encanto "biozone" at localities PD-35 and 68.

Oolina staphyllearia (Schwager, 1866)
Plate 16, figure 7

Fissurina staphyllearia Schwager, 1866, p. 209, pl. 5, fig. 24.
Entosolenia staphyllearia (Schwager). Hadley, 1934, p. 17, pl. 2, figs. 10, 11.
Lagena staphyllearia (Schwager). Bermudez, 1949, p. 118, pl. 11, fig. 4; Cushman, 1934, p. 120, pl. 14, fig. 5.

Description.—Test free, unilocular, ovate in side view, circular to slightly compressed in cross-section; wall calcareous, hyaline, finely perforate; base ornamented with two to four thick spines with a length almost equal to radius of test, spaced in regular intervals along a median line; aperture terminal, slightly produced, an elongate slit in plane of compression and in same alignment as basal spines.

Discussion.—The Mexican specimens of *O. staphyllearia* are not as compressed in end view as are Schwager's types but are similar in all other respects. *Oolina longispina* (Brady, 1884) differs from *O. staphyllearia* in possessing spines whose length equals one to two test diameters.

Distribution.—This species has been recorded from the Pliocene of Car Nicobar and Fiji; the Tertiary of Dominican Republic, and Cuba. It is rare at localities PD-58, 35, and 68 in the Encanto "biozone".

Genus **PARAFISSURINA** Parr, 1947

Parafissurina pseudomarginata (Buchner, 1940)

Plate 15, figure 8

Lagena pseudomarginata Buchner, 1940, p. 534, pl. 27, figs. 566–575.

Parafissurina marginata (Walker and Jacob) [*sic*]. Puri, 1953, p. 127, pl. 26, fig. 9 (not *Vermiculum marginatum* Montagu, 1803—Walker and Jacob citation incorrect).

Lagena marginata (Montagu). Agip Mineraria, 1957, pl. 18, figs. 3, 3a (not *Vermiculum marginatum* Montagu, 1803).

Description.—Test free, large, unilocular, with entosolenian tube, compressed, ovate in transverse section, circular in side view, apertural end slightly produced; wall calcareous, hyaline, smooth, finely perforate; periphery with distinct keel, moderately wide, thin near the base and becoming thicker and rounded approaching the apertural end; aperture a crescentic subterminal slit at one side of the test with extension of the wall and keel projecting above the slit.

Discussion.—Buchner (1940, pl. 27) illustrates several forms of *Parafissurina pseudomarginata* (Buchner). The form which most resembles the Mexican specimens is that referred to as forma *inaequimarginata* by Buchner (1940).

The specimen illustrated by Bermudez (1949, pl. 10, fig. 57) and assigned to *Lagena marginata* (Walker and Boys) may be *P. pseudomarginata* (Buchner).

Distribution.—*Parafissurina pseudomarginata* was described from the Holocene and Tertiary of Italy. It is recorded as *P. marginata* from the Miocene (Choctawhatchee Formation) of Florida. It is rare at localities PD-35, 52, and 56 in the Encanto "biozone".

Superfamily **ROBERTINACEA** Reuss, 1850

Family **EPISTOMINIDAE** Wedekind, 1937

Genus **HOEGLUNDINA** Brotzen, 1948

Hoeglundina elegans (d'Orbigny, 1826)

Plate 14, figures 4–5

Rotalia (*Turbinulina*) *elegans* d'Orbigny, 1826, p. 276, Modeles no. 54 (figured in Parker, Jones, and Brady, 1871, pl. 12, fig. 142).

Epistomina elegans (d'Orbigny). Cushman and Jarvis, 1930, p. 365, pl. 34, figs. 1a–c; LeRoy, 1941a, p. 40, pl. 1, figs. 5, 6, 7; Asano, 1951, p. 17, figs. 130–131.

Hoeglundina elegans (d'Orbigny). Phleger and Parker, 1951, p. 22, pl. 12, figs. 1a–b; LeRoy, 1964, p. 38, pl. 6, figs. 27–28; Belford, 1966, p. 190, pl. 36, figs. 8–13.

Description.—Test free, trochospiral, spiral side evolute, umbilical side involute, biconvex in edge view, periphery acute, circular in side view; chambers distinct, seven to nine in the last whorl, increasing in size gradually; sutures distinct, flush with surface, strongly oblique on the spiral side, obliquely radial on the umbilical side; wall calcareous, hyaline, finely perforate, smooth, often with a complex pattern of thickenings on the umbilical side; aperture an elongate slit, extending the breadth of ultimate chamber, in axis of coiling, parallel to peripheral margin on umbilical side, penultimate chamber with a narrow, interiomarginal, extraumbilical slit at the base of chamber.

Discussion.—All specimens from the study material had broken final chambers and were missing the peripheral slit aperture. The specimen figured (Pl. 14, figs. 4–5) possesses the interiomarginal, basal slit connecting the ultimate and penultimate chambers.

Distribution.—*Hoeglundina elegans* is a widely distributed species. It is recorded from the Holocene of the Atlantic and Pacific oceans, Caribbean, Gulf of Mexico, and Mediterranean; Pleistocene of the Gulf Coast; Tertiary of Japan, Okinawa, East Borneo, Papua New Guinea; late Miocene to early Pliocene (Bowden Formation) of Jamaica; and middle Pliocene (Mao Formation) of the Dominican Republic. This species is rare in the Encanto "biozone" at localities SD-4, PD-77, and 79.

Superfamily **BULIMINACEA** Jones, 1875

Family **SPHAEROIDINIDAE** Cushman, 1927a

Genus **SPHAEROIDINA** d'Orbigny, 1826

Sphaeroidina bulloides d'Orbigny, 1826

Plate 14, figure 6

Sphaeroidina bulloides d'Orbigny, 1826, p. 267, Modeles no. 65; Cushman, 1924, p. 36, pl. 7, figs. 1–6; Cushman and Todd, 1945, p. 65, pl. 11, fig. 9; Agip Mineraria, 1957, pls. 4–5, fig. 2; Dieci, 1959, p. 87, pl. 7, figs. 18–19; Akers and Dorman, 1964, p. 54, pl. 11, figs. 9–10; LeRoy, 1964, p. 41, pl. 16, figs. 21–22; LeRoy and Levinson, 1974, p. 8, pl. 5, fig. 2.

Sphaeroidina bulloides d'Orbigny var. *chilostomata* Galloway and Morrey, 1929, p. 32, pl. 5, figs. 1a–b.

Description.—Test free, subglobular, early portion trochospiral, later streptospiral; chambers inflated, distinct, hemispherical, rapidly increasing in size as added, embracing most of the preceding ones, four to six chambers visible, ultimate chamber comprising almost one-half the size of the test; sutures distinct, depressed; wall calcareous, hyaline, smooth, finely perforate; aperture interiomarginal, a crescentic slit at basal margin of the ultimate chamber, surrounded by a lip and nearly closed by a flat tooth.

Discussion.—Marks (1951, p. 70) places *S. austriaca* d'Orbigny, 1846, and *S. variabilis* Reuss, 1851, in synonymy with *S. bulloides.* Renz (1948, p. 167) states that *S. variabilis* Reuss, 1851, is probably synonymous with *S. bulloides*. This is an indication of the variability in form of *S. bulloides*. Several other species such as *S. chilostomata* Galloway and Morrey, 1929, and *S. ciperana* Cushman and Todd, 1949a, may also be conspecific. A review of the holotypes or topotypes of these species needs to be undertaken to solve the problem. Cushman and Todd (1949a), in their study of the genus *Sphaeroidina* and its species, did little to clarify the problem.

Distribution.—Sphaeroidina bulloides is a widely distributed species. It is recorded from the Holocene of the Atlantic, Pacific, Mediterranean, Caribbean, and Gulf of Mexico; Pleistocene of the Gulf of Mexico; Tertiary of Italy, Vienna Basin, Spain, California; late Miocene to early Pliocene (Bowden Formation) of Jamaica; early Miocene (Ponce Formation) of Puerto Rico; middle to late Miocene (Cojimar Formation) of Cuba; and middle Oligocene to early Miocene (Sombrerito Formation) of the Dominican Republic. This species is rare in the Concepcion and Encanto "biozones".

Family **BOLIVINITIDAE** Cushman, 1927a

Genus **BOLIVINA** d'Orbigny, 1839b

Bolivina imporcata Cushman and Renz, 1944

Plate 17, figure 1

Bolivina floridana Cushman var. *regularis* Cushman and Renz, 1941, p. 17, pl. 3, fig. 7 (homonym of *B. regularis* Nuttall, 1928).

Bolivina floridana Cushman var. *imporcata* Cushman and Renz, 1944 (*nom. nov.*), p. 78; Drooger, 1953, p. 130, pl. 21, figs. 5, 7, 8.

Bolivina imporcata Cushman and Renz. Cushman and Renz, 1947, p. 26, pl. 6, fig. 9; Renz, 1948, p. 118, pl. 7, figs. 3a–b; Redmond, 1953, p. 720, pl. 75, figs. 9a–b.

Bolivina palantia Poag, *in* Poag and Sweet, 1972, p. 258, figs. 8–12f.

Description.—Test free, biserial, elongate, twice as long as broad, initial portion rounded with an initial angle of 45° in side view, compressed in edge view; chambers numerous, nine to 11 pairs in the adult, basal margin of each chamber with two lobes, the lobes of each chamber pair aligned to form four rows of overlapping lobes on each side of test, central two rows forming prominent ridges the length of the test; chambers deeply excavated between the lobes; wall calcareous, hyaline, perforate; aperture an elongate loop extending from the base of ultimate chamber to apex, with a distinct toothplate.

Discussion.—Bolivina imporcata differs from *B. floridana* Cushman, 1918b, in possessing more deeply excavated pits between lobes and higher, narrower ridges extending along length of test.

After studying populations of *B. imporcata* from the study area and from the late Pliocene of the subsurface of the Louisiana and Texas continental shelf, I have concluded that *B. imporcata* is highly variable in shape, size, and surface morphology.

Bolivina palantia Poag, *in* Poag and Sweet, 1972 from the Texas continental shelf, falls within the species concept of *B. imporcata* used herein and is therefore a junior synonym.

Distribution.—Bolivina imporcata was described from the middle to late Miocene (Pozon Formation) of Venezuela. The extinction level in the Gulf of Mexico is equivalent to the extinction of *Globorotalia miocenica* Palmer, 1945 (Poag and Sweet, 1972, p. 258). This species is recorded from the Pleistocene of the Gulf of Mexico and Aruba (West Indies), Miocene (Cubagua and Carenero formations) of Venezuela, and the Tubara Formation of Colombia.

Bolivina imporcata occurs in abundance throughout the Concepcion and Encanto "biozones" of the study area. It appears to be restricted to the Gulf of Mexico–Caribbean area.

Bolivina scalprata miocenica Macfayden, 1930

Plate 17, figures 2–3

Bolivina scalprata Schwager var. *miocenica* Macfayden, 1930, p. 61, pl. 4, figs. 22a–b; Cushman, 1937c, p. 84, pl. 9, figs. 32–34; Cushman and Todd, 1945, p. 44, pl. 7, fig. 4; Palmer, 1945, p. 48, pl. 1, figs. 2a–b; Colom, 1946b, p. 107, pl. 6, figs. 164–166.

Bolivina pseudorobusta Valk, 1945, p. 24, pl. 2, figs. 9–10.

Bolivina scalprata Schwager *miocenica* Macfayden. Souaya, 1965, p. 323, pl. 3, fig. 8.

Description.—Test free, compressed, biserial, twice as long as broad, widest near the apertural end, initial end rounded, periphery subacute with a weakly-developed narrow keel; chambers distinct, nine to ten pairs in the adult, broader than high, increasing gradually in size, basal margin of each chamber with deposits of clear shell material forming basal chamber lobes; sutures limbate, raised, strongly curved; wall calcareous, hyaline, coarsely perforate, ornamented by a raised median ridge that extends from the initial end to the penultimate chamber; aperture an elongate narrow slit in the plane of compression, extending from the base of the ultimate chamber to a terminal position, with a toothplate.

Discussion.—Bolivina scalprata miocenica shows a distinctive series of nodes at the basal margin of each chamber, a feature easily seen in transmitted light (see Pl. 17, fig. 3). The raised sutures give the chambers a depressed appearance that can be seen in the SEM photo in Plate 17, figure 2a.

Bolivina malkinae Coryell and Emblich, 1937, is similar to the above species and may be a junior synonym. *Bolivina goesii* Cushman, 1922b, differs from *B. scalprata miocenica* in possessing a finely- rather than coarsely-perforate wall, in its depressed sutures and rhomboid test.

Distribution.—Bolivina scalprata miocenica was described from the Miocene of Egypt. It is recorded from the Plio-Pleistocene of the Island of Ceram (Indonesia), Miocene of Mallorca (Mediterranean Sea), and from the late Miocene to early Pliocene (Bowden Formation) of Jamaica. This species is rare in the Concepcion and Encanto "biozones".

Genus **BRIZALINA** Costa, 1856

Brizalina alata (Seguenza, 1862)
Plate 17, figure 6

Vulvulina alata Seguenza, 1862, p. 115, pl. 2, figs. 5, 5a.
Bolivina beyrichi Reuss var. *alata* (Seguenza). Brady, 1884, p. 422, pl. 53, figs. 2–4.
Bolivina alata (Seguenza). Cushman, 1937c, p. 106, pl. 13, figs. 3–11; Cushman and Todd, 1945, p. 42, pl. 6, fig. 25; Colom, 1946a, p. 160, pl. 10, figs. 173, 176–177, 185–186, 190–193; Hofker, 1951, p. 96, figs. 54a–b; LeRoy, 1964, p. 31, pl. 2, fig. 12.
Brizalina alata (Seguenza). Belford, 1966, p. 24, pl. 1, figs. 1–2.

Description.—Test free, biserial, compressed, elongate, about one-and-one-half times as long as broad, broadest near apertural end, initial end with an inflated proloculus; periphery carinate with a wide keel, the basal portion of each chamber projecting downward to form a serrated margin; chambers distinct, seven to nine pairs, early chambers low and broad, increasing rapidly in size in the adult until height is greater than breadth, distinctly overlapping, very slightly inflated; sutures distinct, curved, slightly depressed; wall calcareous, smooth, finely perforate, except for the upper portion of most chambers; aperture elongate, narrow, surrounded by a thin rim, with a narrow toothplate.

Discussion.—Belford (1966) differentiates *B. alata* (Seguenza) from *B. pseudobeyrichi* (Cushman, 1926b) in that the former species has a much wider keel, and finer perforations. The type figure of *Brizalina superba* (Emiliani, 1949) appears similar to *B. alata* and may be a junior synonym.

Distribution.—Brizalina alata was described from the Pleistocene of Italy. It is recorded from the Holocene of the Atlantic, Pacific, Gulf of Mexico and the Caribbean area; Pleistocene of the Gulf of Mexico; Pliocene of Okinawa and Papua New Guinea; and the Tertiary of the Caribbean and Mediterranean areas. *Brizalina alata* occurs at most localities in the Concepcion and Encanto "biozones".

Brizalina albatrossi (Cushman, 1922)
Plate 17, figures 4–5

Bolivina albatrossi Cushman, 1922b, p. 31, pl. 6, fig. 4; Cushman, 1937c, p. 153, pl. 18, figs. 22–24; Phleger and Parker, 1951, p. 12, pl. 6, figs. 15, 16; Hofker, 1951, p. 84, figs. 46–48; LeRoy, 1964, p. 31, pl. 2, fig. 15; Feyling-Hanssen, 1964, p. 318, pl. 16, fig. 6; LeRoy and Hodgkinson, 1975, p. 432, pl. 9, fig. 1.

Description.—Test free, biserial, elongate, length two-and-one-half times the width, broadest near apertural end, initial end rounded, periphery broadly rounded, ovate in transverse section; eight to nine pairs of chambers in the adult, slightly inflated, increasing gradually in size as added; a triangular plug of calcite is developed on the upper and inner margin of each chamber in the last two-thirds of test; sutures distinct, except in early portion, somewhat limbate, strongly oblique; wall calcareous, hyaline, coarsely perforate, with coarse surface ornamentation, consisting of an irregular, rough, pitted surface for the initial half of test, almost smooth near the apertural end; aperture elongate, extending from the base of the ultimate chamber to a terminal position, surrounded by an elevated lip and imperforate area, with a narrow toothplate.

Discussion.—Brizalina irregularis (LeRoy, 1939) from the Neogene of Sumatra differs from *B. albatrossi* in possessing a more irregular, pitted surface, and a more angular periphery.

Distribution.—Brizalina alabatrossi was described from the Holocene off the North Carolina coast. It is recorded from the Holocene of the Gulf of Mexico, Caribbean, and Atlantic Ocean; and the Pleistocene of the Gulf of Mexico and Norway. This species is common in the lower Concepcion and Encanto "biozones" at most localities.

Brizalina barbata (Phleger and Parker, 1951)
Plate 17, figure 7

Bolivina barbata Phleger and Parker, 1951, p. 13, pl. 6, figs. 12–13; Drooger and Kaasschieter, 1958, p. 28, pl. 1, fig. 2; Andersen, 1961, p. 93, pl. 20, figs. 6a–b; Akers and Dorman, 1964, p. 24, pl. 8, fig. 34.

Description.—Test free, biserial, compressed, two-and-one-half times as long as broad, broadest near apertural end, initial end with inflated proloculus; narrow carina broken into sharp, downward-curving projections at the basal portion of each chamber; ten pairs of chambers in the adult, narrow, curved, increasing gradually in size as added, somewhat inflated; sutures distinct, narrow, slightly depressed, strongly curved; wall calcareous, hyaline, smooth, finely perforate; aperture loop-shaped, extending up from base of final chamber, with a small tooth.

Discussion.—*Brizalina barbata* differs from *B. alata* (Seguenza, 1862) in its smaller size, more narrow carina, and greater length-to-width ratio of test.

Distribution.—*Brizalina barbata* was described from the Holocene of the Gulf of Mexico. It is also recorded from the Holocene of the Caribbean, and the Pleistocene of the Gulf of Mexico. This species is rare in the Concepcion and Encanto "biozones".

Brizalina cf. **B. furcata** (Cushman and Jarvis, 1930)
Plate 17, figures 10–11

Bolivina furcata Cushman and Jarvis, 1930 (part), p. 363, pl. 33, figs. 7a–b (not fig. 8).

Description.—Test free, biserial, elongate, length about two-and-one-half times the width, compressed, rhomboid in transverse section, initial end with a large spine, periphery acute with a keel and irregular serrations, greatest width at last pair of chambers; nine to ten pairs of chambers in the adult, large globular proloculus with chambers increasing gradually in size as added, curving down at margin; sutures distinct, thickening along median suture line with some clear calcite deposits, thin and sharply curved along chamber margins, generally flush with surface; wall calcareous, smooth, finely perforate; aperture elongate, extending from the base of the ultimate chamber to a terminal position, with a narrow toothplate.

Discussion.—This species differs from *Brizalina furcata* (Cushman and Jarvis, 1930) in possessing an irregular serrated keel. The keel of *B. furcata* is smooth and unserrated according to the type description of Cushman and Jarvis (1930). The specimens from the study area may be a subspecies of *B. furcata*.

The clear calcite deposits along the inner chamber margins, the prominent spine and the serrated keel are diagnostic features of *Brizalina* cf. *B. furcata*.

Distribution.—This species is rare in the Concepcion and Encanto "biozones".

Brizalina inflata (Heron-Allen and Earland, 1913)
Plate 17, figure 9

Bolivina inflata Heron-Allen and Earland, 1913, p. 68, pl. 4, figs. 16–19; Cushman, 1937c, p. 166, pl. 18, fig. 16; Todd and Brönnimann, 1957, p. 33, pl. 8, figs. 32–34.

Bolivina (*Bolivina*) *inflata* Heron-Allen and Earland. Smith, 1963, p. 22, pl. 30, figs. 22, 23.

Description.—Test free, small (length: 0.32 mm), biserial, twice as long as broad, broadest near apertural end, periphery rounded, lobulate in side view, initial end rounded; chambers inflated, overlapping, usually five to nine pairs, increasing rapidly in size; sutures distinct, depressed; wall calcareous, smooth, finely perforate; aperture an elongate loop extending from base of ultimate chamber to apex.

Discussion.—*Brizalina subspinescens* (Cushman, 1922b) differs from *B. inflata* in possessing a pitted or spinose ornamentation of the chambers.

Distribution.—*Brizalina inflata* was described from the Holocene of the British Isles. It is recorded from the Holocene of the Atlantic, Pacific and Caribbean Sea. This species is rare in the Concepcion and Encanto "biozones".

Brizalina striatula (Cushman, 1922)
Plate 17, figure 12

Bolivina striatula Cushman, 1922d, p. 27, pl. 3, fig. 10; Cushman, 1937c, p. 154, pl. 18, figs. 30–31; Cushman and McCulloch, 1942, p. 212, pl. 26, figs. 12, 13; Bermudez, 1949, p. 194, pl. 12, fig. 50.

Bolivina isidroensis [?] Cushman and Renz, 1941, p. 17, pl. 3, fig. 8.

Bolivina striatula Cushman forma *typica*. Boltovskoy, 1959, p. 82, pl. 11, fig. 32.

Description.—Test free, biserial, four times as long as broad, rounded in transverse section, broadest near apertural end, initial end rounded; 12 to 13 pairs of chambers in the adult, slightly inflated, increasing gradually in size; sutures distinct, slightly limbate, strongly oblique; wall calcareous, coarsely perforate; the upper portion of chambers imperforate, ornamented by numerous longitudinal striae, restricted to the earlier half of test, remainder of test smooth; aperture elongate, extending from the base of the ultimate chamber to a terminal position, with a narrow tooth.

Discussion.—This species differs from *B. striatula spinata* (Cushman, 1936a) in lacking the basal spine.

Distribution.—*Brizalina striatula* was described from the Holocene of the Atlantic. It is recorded from Holocene of the Pacific and Caribbean; Miocene to early Pliocene (La Salinas Formation) of the Dominican Republic, and late Miocene to early Pliocene (Bowden Formation) of Jamaica. It is rare in the upper Concepcion and Encanto "biozones".

Brizalina striatula spinata (Cushman, 1936)
Plate 17, figure 8

Bolivina striatula Cushman var. *spinata* Cushman, 1936a, p. 59, pl. 8, figs. 9a–b; Phleger and Parker, 1951, p. 14, pl. 7, fig. 7.

Bolivina striatula Cushman forma *spinata* Cushman. Boltovskoy, 1959, p. 83, pl. 11, fig. 33.

Bolivina spinata Cushman. Andersen, 1961, p. 93, pl. 20, figs. 11a–b; Akers and Dorman, 1964, p. 26, pl. 8, fig. 10.

Description.—Test free, biserial, four times as long as broad, rounded in transverse section, broadest near apertural end, initial end with short spine; chambers distinct, usually 12 to 13 pairs, very slightly inflated, increasing gradually in size; sutures slightly limbate, curved, slightly depressed in the adult portion; wall calcareous, coarsely perforate, upper portion of chambers in first two-thirds of test imperforate, ornamented by numerous, longitudinal narrow costae extending from proloculus to almost two-thirds the length of the test; aperture elongate, extending from the base of the ultimate chamber to a terminal position, narrow at the base and expanding toward the upper end, with a narrow toothplate.

Distribution.—Brizalina striatula spinata was described from the Holocene of the Gulf of Mexico. It is recorded from Holocene of the Atlantic, Caribbean; and Pleistocene of the Gulf of Mexico. It is rare in the Concepcion and Encanto "biozones".

Brizalina subaenariensis (Cushman, 1922)

Plate 17, figure 13

Bolivina subaenariensis Cushman, 1922b, p. 46, pl. 7, fig. 6; Cushman, 1937c, p. 155, pl. 18, figs. 26–28; Drooger, 1953, p. 132, pl. 21, figs. 11–13; Todd and Brönnimann, 1957, p. 34, pl. 8, figs. 19–20; Akers and Dorman, 1964, p. 26, pl. 8, figs. 20, 28.

Brizalina subaenariensis (Cushman). Murray, 1971, p. 111, pl. 45, figs. 5–7.

Description.—Test free, biserial, compressed, length twice the width; widest near apertural end, initial end with a short spine; periphery acute, carinate; seven to nine pairs of chambers in the adult, narrow, curved, increasing gradually in size, slightly inflated; sutures distinct, slightly depressed, strongly curved; wall calcareous, hyaline, finely perforate, ornamented with two or more costae, center two extending from the initial end two-thirds the length of test, additional costae shorter, on either side of the other two; aperture elongate, narrow, surrounded by a rim, with a narrow toothplate.

Discussion.—Brizalina subaenariensis mexicana (Cushman, 1922b) differs from *B. subaenariensis* in possessing costae that continue the length of the test.

Distribution.—Brizalina subaenariensis was described from the Holocene of the Atlantic. It is recorded from the Holocene and Pleistocene of the Caribbean and Gulf of Mexico. It is abundant in the upper and lower Concepcion "biozones" and common in the Encanto "biozone".

Genus **LATEROSTOMELLA**

Klasz and Rérat, 1962

Laterostomella subspinescens (Cushman, 1922)

Plate 17, figure 14

Bolivina subspinescens Cushman, 1922b, p. 48, pl. 7, fig. 5; Cushman, 1937c, p. 157, pl. 19, figs. 1–3; Phleger and Parker, 1951, p. 15, pl. 7, figs. 11–12; Boltovskoy, 1959, p. 82, pl. 11, fig. 31; Akers and Dorman, 1964, p. 27, pl. 8, figs. 6, 15.

Brizalina (*Pseudobrizalina*) cf. *B.* (*P.*) *lobata* (Brady) Zweig-Strykowski and Reiss, 1975, p. 110, pl. 7, figs. 1–10, pl. 8, figs. 1–4 (not *Bolivina lobata* Brady, 1881).

Description.—Test free, biserial, small, length twice the width, broadest near apertural end, initial end subrounded or with a spine, slightly compressed, ovate in transverse section; periphery lobate in side view; chambers inflated, five to six pairs in the adult, increasing uniformly in size; sutures distinct, strongly depressed, slightly oblique; wall calcareous, perforate, pitting or spinose ornamentation on the basal portion of chambers, the upper portion of each chamber smooth; aperture oval, extending from base of ultimate chamber to a terminal position, with a thickened rim; no toothplate observed.

Discussion.—Laterostomella subspinescens differs from *L. spinescens* Cushman, 1911, in the coarser ornamentation and the distinct shoulder on each chamber. It differs from *Laterostomella zanzibarica* (Cushman, 1936a) in the absence of raised sutures on the early portion of test.

Distribution.—Laterostomella subspinescens was described from the Holocene of the Atlantic. It is recorded from the Holocene and Pleistocene of the Gulf of Mexico; Holocene of the Caribbean, and Gulf of Elat. It is rare in the study area, occurring only at localities PD-52 and 68 in the Encanto "biozone".

Genus **RECTOBOLIVINA** Cushman, 1927a

Rectobolivina limbata costulata (Cushman, 1922)

Plate 18, figure 1

Bolivina limbata Brady var. *costulata* Cushman, 1922d, p. 26, pl. 3, fig. 8.

Loxostoma limbata (Brady) var. *costulata* (Cushman). Palmer and Bermudez, 1936a, p. 248.

Loxostoma limbatum (Brady) var. *costulatum* (Cushman). Cushman, 1937c, p. 187, pl. 21, figs. 30–31; Cushman, 1942, p. 36, pl. 10, figs. 2–4; Cushman and McCulloch, 1942, p. 223, pl. 28, figs. 9–10.

Loxostomum limbatum (H. B. Brady) var. *costulatum* (Cushman). LeRoy, 1964, p. 33, pl. 2, fig. 20.

Rectobolivina limbata (Brady). Belford, 1966 (part), p. 49, pl. 4, figs. 12–14 (not fig. 15).

Description.—Test free, elongate, biserial in early stage, becoming uniserial, compressed, oval in transverse section, three to four times as long as broad, widest at middle; broadly rounded periphery and initial end; chambers slightly inflated, biserial stage with four to five pairs of chambers, uniserial stage with three to four chambers; sutures indistinct in early portion, distinct in later portion, limbate, strongly oblique in biserial stage, depressed and curved in uniserial stage; wall calcareous, hyaline, finely perforate, ornamented by very fine longitudinal costae, generally restricted to biserial stage, distinct on earlier chambers, disappearing on later chambers; aperture terminal, large, oval with raised thickened imperforate rim and folded toothplate.

Discussion.—Belford (1966, p. 49) placed both smooth and striate forms in *Rectobolivina limbata*

(Brady, 1881). Differences in ornamentation were considered by Belford to be possibly part of the intraspecific variation of *R. limbata*. He suggested that detailed investigations be made of such features as the toothplate and pores of both costate and smooth forms occurring in a population. *Rectobolivina limbata costulata* is retained herein for costate forms.

Distribution.—This subspecies was described from the Holocene of the Western Atlantic. It is recorded from the Holocene of the Pacific, Pliocene of Okinawa, Tertiary of Cuba and Aruba Island, and early Pleistocene (Playa Grande Formation) of Venezuela. It is rare in the Encanto "biozone" at localities SD-4 and PD-68.

Family **EOUVIGERINIDAE** Cushman, 1927a

Genus **SIPHONODOSARIA** Silvestri, 1924

Siphonodosaria hyugaensis (Ishizaki, 1943)

Plate 19, figure 1

Ellipsonodosaria hyugaensis Ishizaki, 1943, p. 686, figs. 12–13; Asano, 1951, p. 27, fig. 118.

Description.—Test free, uniserial, small, slender, straight or slightly curved, length seven times the width, initial end rounded; chambers inflated, eight to ten in the adult, subglobular in early portion, more elongate in last half of test; sutures distinct, limbate, slightly depressed in early portion, more depressed in later portion; wall calcareous, hyaline, finely perforate, ornamented by small spines at basal end of each chamber, final chamber weakly hispid throughout; aperture terminal, subcircular with a tooth and seven to ten denticulations, at end of a short neck ornamented with short spines and a phialine lip.

Discussion.—Siphonodosaria hyugaensis differs from *S. oinomikadoi* (Ishizaki, 1943) in its greater length-to-width ratio and constriction between chambers.

Distribution.—Siphonodosaria hyugaensis was described from the early Pliocene of Japan. It is rare in the Concepcion and Encanto "biozones".

Siphonodosaria oinomikadoi (Ishizaki, 1943)

Plate 19, figure 2

Ellipsonodosaria oinomikadoi Ishizaki, 1943, p. 685, figs. 7–10; Asano, 1951, p. 28, figs. 125–126.

Discussion.—Test free, uniserial, elongate, length four to five times the width, circular in cross-section; chambers distinct, six to eight in the adult, increasing gradually in size, inflated, embracing; sutures limbate, not depressed in the early portion, slightly depressed in the later two-thirds of test, wall calcareous, hyaline, finely perforate, generally smooth, later chambers have small scattered spines; aperture terminal, circular, with a distinct tooth and eight to nine denticulations on inner margin of lip at end of a short neck ornamented with numerous spines.

Discussion.—Ishizaki described the type as having a "T-shaped tooth". The Mexican specimens possess a straight tooth with many secondary dentitions in the aperture (Pl. 19, fig. 2d). This difference may be only an intraspecific variation.

Ellipsonodosaria matanzana Palmer and Bermudez, 1936b, is similar to *S. oinomikadoi* but the chambers are not as embracing and the last chamber is more elongate than in any of the Mexican specimens.

Distribution.—Siphonodosaria oinomikadoi was described from the early Pliocene of Japan. It is also recorded from the Pliocene of Taiwan. This species is rare in the lower Concepcion and Encanto "biozones".

Genus **STILOSTOMELLA** Guppy, 1894

Stilostomella japonica (Ishizaki, 1943)

Plate 19, figure 3

Ellipsonodosaria japonica Ishizaki, 1943, p. 682, figs. 14–15; Asano, 1951, p. 27, figs. 119–120.

Description.—Test free, uniserial, elongate, length eight to ten times the width, slightly arcuate; chambers distinct, ten to 12 in the adult, gradually increasing in size, early chambers slightly inflated, later chambers more inflated and elongate; sutures slightly depressed, limbate in early chambers; wall calcareous, hyaline, finely perforate, ornamented with hispid projections longitudinally aligned, weakly developed on earlier chambers, more distinct on later ones; aperture terminal, broken.

Discussion.—All specimens obtained from the study area had broken apertures. Ishizaki (1943) describes *S. japonica* with a phialine lip and a distinct tooth.

The last few chambers exhibit an unusual spinose ornamentation (see Pl. 19, figs. 3a, 3d). Each spine emerges from a groove in the chamber wall just above the spine. These spines are aligned longitudinally but not in rows.

Distribution.—Stilostomella japonica was described from the early Pliocene of Japan. It is rare in the upper Concepcion "biozone" occurring only at locality PD-40.

Stilostomella lepidula (Schwager, 1866)

Plate 19, figure 4

Nodosaria lepidula Schwager, 1866, p. 210, pl. 5, figs. 27–28.
Nodosaria monilis Silvestri, 1872, p. 71, pl. 8, figs. 173–183.
Nodosaria antillea Cushman, 1923, p. 91, pl. 14, fig. 9.
Nodogenerina lepidula (Schwager). Cushman, 1934, p. 122, pl. 14, figs. 15–16.
Ellipsonodosaria recta Palmer and Bermudez, 1936b, p. 297, pl. 18, figs. 6–7.

Siphonodosaria recta (Palmer and Bermudez). Bermudez, 1949, p. 227, pl. 14, fig. 26.
Siphonodosaria antillea (Cushman). Akers and Dorman, 1964, p. 53, pl. 9, fig. 34.
Stilostomella antillea (Cushman). Schnitker, 1971, p. 212, pl. 5, figs. 3a–b.

Description.—Test free, uniserial, small, slender, initial end rounded, sometimes with a short spine; chambers inflated, subglobular, increasing fairly rapidly in size, six to eight in the adult, strongly embracing in the early portion of test, more remote in the later portion; sutures distinct, slightly depressed in early portion, strongly depressed in later portion; wall calcareous, hyaline, finely perforate, ornamented by a series of spines encircling the lower half of each chamber, spines in single or multiple rows, the upper half of chamber smooth; aperture terminal, circular to ovate, with a prominent T-shaped tooth projecting into the opening from a phialine lip; at end of a short neck, which is ornamented by a collar of spines located midway along its length.

Discussion.—*Stilostomella paucistriata* (Galloway and Morrey, 1929) differs from *S. lepidula* in its much larger test, more uniform size of chambers, and in possessing striae on the constriction between chambers.

Distribution.—*Stilostomella lepidula* was described from the Pliocene of Car Nicobar. It is recorded from Holocene of the Pacific and Atlantic; Pleistocene of the Gulf of Mexico; Neogene of Ecuador, and Aruba. It is rare in the Concepcion and Encanto "biozones".

Stilostomella paucistriata
(Galloway and Morrey, 1929)
Plate 19, figure 5

Nodosaria intermittens Nuttall, 1928, p. 82, pl. 4, fig. 17 (homonym of *Nodosaria intermittens* Roemer, 1838).
Nodosarella paucistriata Galloway and Morrey, 1929, p. 42, pl. 6, fig. 12; Coryell and Rivero, 1940, p. 343, pl. 42, figs. 21–23; Galloway and Heminway, 1941, p. 440, pl. 35, figs. 7–9.
Ellipsonodosaria verneuili (d'Orbigny) var. *paucistriata* (Galloway and Morrey). Cushman, 1929a, p. 97, pl. 14, figs. 4–5; Cushman and Jarvis, 1934, pl. 10, figs. 2, 3; Colom, 1946b, p. 70, pl. 9, figs. 201–203.
Ellipsonodosaria ketienziensis Ishizaki, 1943, pl. 684, figs. 1, 6, 11.
Siphonodosaria paucistriata (Galloway and Morrey). Drooger, 1953, p. 137, pl. 24, fig. 2.

Description.—Test free, uniserial, slightly curved, circular in cross-section, elongate, length six to nine times the width, initial end with a small asymmetrical spine; eight to 12 chambers in the adult, elongate and strongly embracing in first third of test, later subglobular and separated, increasing slowly in size as added; sutures distinct, less so in the first third of test, more depressed as chambers added, strongly limbate; wall calcareous, hyaline, finely perforate, ornamented by faint spines on lower portion of the last few chambers, the constricted area between the chambers ornamented by short striae that are restricted to the uppermost and lowermost portion of the later chambers; aperture terminal, kidney-shaped, with a distinct anchor-shaped tooth projecting into the opening, with a phialine lip at the end of a long neck ornamented by a collar of short spines located midway along its length.

Discussion.—The apertural tooth of this species is formed by the infolding of the inner margin of the neck (Pl. 19, figs. 5c, d). The spines occurring near the base of each of the last few chambers appear to be the remnants of the spinose collar projecting through the chamber wall. *Ellipsonodosaria helenae* Samoilova, 1947, is similar and may be a junior synonym, but the author failed to discuss any chamber ornamentation in the description of the type specimen. The type figure, however, appears to have similar constrictions near the suture areas.

Distribution.—*Stilostomella paucistriata* was described from the Neogene of Ecuador. It is recorded from the early Pliocene of Japan and Taiwan, Miocene of Aruba, Miocene of Mallorca, Oligocene and early Miocene (Cibao and Ponce Formations) of Puerto Rico, and the late Miocene to early Pliocene (Bowden Formation) of Jamaica. It is rare in the study area, restricted to the Encanto "biozone".

Family **BULIMINIDAE** Jones, 1875

Subfamily **BULIMININAE** Jones, 1875

Genus **BULIMINA** d'Orbigny, 1826

Bulimina aculeata d'Orbigny, 1826
Plate 20, figure 1

Bulimina aculeata d'Orbigny, 1826, p. 269; Cushman and Todd, 1945, p. 39, pl. 6, fig. 11; Colom, 1946a, p. 159, pl. 10, figs. 174–175; Cushman and Parker, 1947, p. 120, pl. 28, figs. 8–11; Hofker, 1951, p. 151, text-figs. 92–94; Phleger and Parker, 1951, p. 15, pl. 7, fig. 23; Barker, 1960, p. 104, pl. 51, figs. 7–9; LeRoy, 1964, p. 30, pl. 11, fig. 7; Belford, 1966, p. 59, pl. 5, figs. 1–3.
Bulimina pupoides d'Orbigny var. *spinulosa* Williamson, 1858, p. 62, pl. 5, text-fig. 128.

Description.—Test free, triserial, length one-and-one-half times the width, widest near middle of test, ovate in transverse section, initial end subacute; chambers inflated, rounded, four to five whorls, with chambers increasing rapidly in size; sutures distinct, depressed, generally obscured by ornamentation on early portion of test; wall calcareous, hyaline, finely perforate, lower half of test ornamented with fine to coarse spines, extending downward from chamber wall, commonly with several large spines at the initial end; chambers of last whorl smooth but with a few spines along the lower portion of each chamber; aperture a loop-shaped slit with toothplate in the apertural face at the inner margin of the ultimate chamber, surrounded by a raised lip.

Discussion.—The ornamentation of *Bulimina aculeata* varies greatly in the study material. Some specimens from the study area are finely hispid, but others have only a few well-developed spines. There is also variation in the shape of the test. Some individuals have more highly inflated chambers, producing a smaller length-to-width ratio: other specimens are more elongate. *Bulimina aculeata* frequently has been confused with *Bulimina marginata* d'Orbigny, 1826, and was even placed in synonymy with *B. marginata* by Höglund (1947; *fide* Belford, 1966, p. 58).

Bulimina aculeata is a distinct species and differs from *B. marginata* by not possessing sharply "undercut" lower chamber margins and a spinose rim (see Pl. 20, figs. 1, 3).

Distribution.—*Bulimina aculeata* was described from the Holocene of the Adriatic Sea. It is also recorded from the Holocene of the Pacific, Atlantic and Gulf of Mexico; Pleistocene of the Gulf of Mexico; Pliocene and Miocene of Japan; Neogene of the Vienna Basin and Mallorca; late Miocene to early Pliocene (Bowden Formation) of Jamaica; and Neogene (Shimajiri Formation) of Okinawa. It is common in the Concepcion and Encanto "biozones".

Bulimina alazanensis Cushman, 1927
Plate 20, figure 2

Bulimina alazanensis Cushman, 1927c, p. 161, pl. 25, fig. 4; Bermudez, 1949, p. 180, pl. 12, fig. 1; Phleger and Parker, 1951, p. 16, pl. 7, figs. 24, 29; Souaya, 1965, p. 314, pl. 2, fig. 9; Belford, 1966, p. 62, pl. 5, figs. 9–11.

Description.—Test free, small, triserial, length almost twice the width, widest near apertural end, initial end acute, circular in transverse section; chambers slightly inflated, increasing gradually in size; sutures indistinct; wall calcareous, hyaline, coarsely perforate, ornamented by 15 or more costae that are continuous from the proloculus to the base of the last two chambers; aperture an elongate slit with toothplate, located in a depression in the inner margin of ultimate chamber.

Discussion.—Belford (1966, p. 63) notes that *Bulimina alazanensis* and *B. rostrata* Brady, 1884, may overlap geographically and that an investigation into the intraspecific variability of these species is needed. They are considered herein to be two distinct species. *Bulimina rostrata* possesses costae that continue the length of the test and has a basal spine.

Distribution.—*Bulimina alazanensis* was described from the late Oligocene (Alazan Formation) of Mexico. It is recorded from the Holocene of the Gulf of Mexico, Pacific, and Atlantic; Neogene of the Dominican Republic, Colombia, Venezuela, Italy, Egypt and Papua New Guinea; middle to late Miocene (Cojimar Formation) of Cuba; and Oligo-Miocene (Cipero Formation) of Trinidad. It is rare and restricted to the Encanto "biozone".

Bulimina marginata d'Orbigny, 1826
Plate 20, figure 3

Bulimina marginata d'Orbigny, 1826, p. 269; Bermudez, 1949, p. 182, pl. 12, fig. 11; Hofker, 1951, p. 154, text-figs. 95–96; Phleger and Parker, 1951, p. 16, pl. 7, figs. 27–28; Todd and Brönnimann, 1957, p. 32, pl. 8, figs. 4–5; Barker, 1960, p. 104, pl. 51, figs. 3–5; LeRoy, 1964, p. 30, pl. 11, fig. 2; Murray, 1971, p. 119, pl. 49, figs. 1–7.

Description.—Test free, triserial, length one-and-one-half times the width, widest near middle of test, ovate in transverse section, initial end acute; chambers inflated, undercut at the margin, rapidly increasing in size as added; sutures distinct, depressed, generally obscured by ornamentation on early portion, oblique in the later portion; wall calcareous, hyaline, finely perforate, smooth, margins of chambers ornamented with short downward-projecting spines decreasing in number on later chambers; aperture a loop-shaped slit with toothplate in the apertural face at the inner margin of the ultimate chamber, surrounded by a raised lip.

Discussion.—Belford (1966, p. 58) noted that *Bulimina marginata* and *Bulimina aculeata* d'Orbigny, 1826, are closely related species, but *Bulimina marginata* differs from *B. aculeata* in having distinctly "undercut" lower chamber margins. Specimens of *B. marginata* and *B. aculeata* from the study area are distinct, with features typical of the species.

Distribution.—*Bulimina marginata* was described from the Holocene of the Adriatic Sea. It is recorded from the Holocene of the Atlantic, Pacific, Gulf of Mexico, Caribbean, and Mediterranean; Pleistocene of the Gulf of Mexico; Pliocene of Japan and Okinawa; Miocene of Aruba and Florida; late Miocene to early Pliocene (Gurabo Formation) of the Dominican Republic; and late Miocene to early Pliocene (Bowden Formation) of Jamaica. It is rare in the study area, occurring in the Concepcion "biozone".

Bulimina spicata Phleger and Parker, 1951
Plate 20, figure 5

Bulimina spicata Phleger and Parker, 1951, p. 16, pl. 7, figs. 25, 30–31; Parker, 1954, p. 510, pl. 6, figs. 22, 23; Akers and Dorman, 1964, p. 29, pl. 7, fig. 22.

Description.—Test free, small, triserial, consisting of three to four whorls, length almost twice the width, last-formed whorl over one-half the test, initial end with short spines; chambers distinct, inflated, increasing rapidly in size, slightly overhanging previous ones;

sutures indistinct on early portion of test, obscured by ornamentation, distinct and depressed on later portion; wall calcareous, hyaline, coarsely perforate except for upper portion of last two chambers, which are imperforate, ornamented by poorly-developed costae terminating as sharp spines below outer margins of chambers; aperture elongate, with well-developed toothplate, extending from suture to apex of ultimate chamber, in a slight depression, surrounded by a raised lip.

Discussion.—*Bulimina spicata* differs from *B. striata mexicana* Cushman, 1940, in its smaller size and less-developed costae.

Distribution.—*Bulimina spicata* was described from the Holocene of the Gulf of Mexico. It is recorded from the Holocene of the Caribbean and Pleistocene of the Gulf of Mexico. It is rare in the Concepcion and Encanto "biozones" but occurs at most localities.

Bulimina striata mexicana Cushman, 1940
Plate 20, figure 4

Bulimina inflata Seguenza var. *mexicana* Cushman, 1922b, p. 95, pl. 21, fig. 2.

Bulimina inflata Seguenza. Cushman and Jarvis, 1930, p. 362, pl. 33, fig. 5 (not Seguenza, 1862).

Bulimina striata d'Orbigny var. *mexicana* Cushman, *in* Cushman and Parker, 1940, p. 16, pl. 3, fig. 9; Cushman and Todd, 1945, p. 40, pl. 6, fig. 10; Cushman and Parker, 1947, p. 119, pl. 28, fig. 4; Phleger and Parker, 1951, p. 16, pl. 7, figs. 26, 32.

Bulimina striata mexicana Cushman. Akers and Dorman, 1964, p. 29, pl. 7, fig. 15.

Description.—Test free, triserial, slightly longer than broad, consisting of four to five whorls, widest across last-formed whorl; chambers inflated, increasing in size as added, slightly overhanging the previous ones; sutures distinct in the last whorl, depressed, obscured in earlier whorls by the overlapping chambers; wall calcareous, hyaline, finely perforate, ornamented with thick costae on lower half of each chamber, many costae extending downward across the sutures of previous chambers forming downward-projecting spines at the chamber margins; initial end of test with a prominent spine; aperture elongate, loop-shaped, beginning at the junction of the penultimate and antepenultimate chambers and extending up the face of the ultimate chamber to a terminal position, with lip surrounding the margin of the opening and a well-formed toothplate projecting outward from lip.

Discussion.—Cushman and Parker (1940, p. 16), made extensive studies of *Bulimina striata* d'Orbigny, 1843, and *B. inflata* Seguenza, 1862, and concluded that the species originally designated *B. inflata* var. *mexicana* Cushman, 1922b, was actually a form of *B. striata* d'Orbigny, 1843. They determined that *B. striata* differs from *B. inflata* in having definite collared, or undercut, chamber margins, and a prominent spine on the initial end.

Bulimina striata mexicana Cushman, 1940, differs from *B. striata* d'Orbigny, 1843, in having costae that terminate in short spines at the chamber margins. *Bulimina nipponica* Asano, 1958, is similar to *B. striata mexicana* and may be a junior synonym.

Distribution.—*Bulimina striata mexicana* was described from the Holocene of the Gulf of Mexico. It is recorded from the Holocene of the Pacific, Atlantic, and Caribbean; Pleistocene of the Gulf of Mexico; and the late Miocene to early Pliocene (Bowden Formation) of Jamaica. It is rare in the study area, generally restricted to the lower Concepcion and Encanto "biozones".

Genus **GLOBOBULIMINA** Cushman, 1927a

Globobulimina pacifica Cushman, 1927
Plate 21, figure 1

Globobulimina pacifica Cushman, 1927a, p. 67, pl. 14, figs. 12a–b; Franklin, 1944, p. 314, pl. 46, fig. 19; LeRoy, 1944a, p. 27, pl. 5, fig. 12; Cushman and Parker, 1947, p. 134, pl. 29, fig. 37; Asano, 1958, pl. 11, pl. 2, figs. 10a–b; LeRoy, 1964, p. 30, pl. 14, fig. 3.

Description.—Test free, triserial, pyriform in side view, broadest near base, decreasing in width toward the apertural end, ovate in transverse section; chambers inflated, strongly overlapping, last whorl only visible in side view, earlier chambers seen in basal view; sutures distinct, flush with surface; wall calcareous, smooth, finely perforate; aperture loop-shaped, terminal, with a broad projecting toothplate.

Discussion.—*Globobulimina pacifica* Cushman var. *scalprata* Cushman and Todd, 1945, differs from *G. pacifica* in possessing many fine, longitudinal striae.

Distribution.—*Globobulimina pacifica* was described from the Holocene of the eastern Pacific. It has been recorded from the Holocene of the Atlantic, Pliocene of Fiji, Oligocene (Carapita Formation) of Venezuela, Neogene (Shimajiri Formation) of Okinawa, and Neogene of the East Indies. It is rare in the Concepcion and Encanto "biozones".

Genus **PRAEGLOBOBULIMINA** Hofker, 1951

Praeglobobulimina ovata (d'Orbigny, 1846)
Plate 21, figure 3

Bulimina ovata d'Orbigny, 1846, p. 185, pl. 11, figs. 13, 14; LeRoy, 1941a, p. 32, pl. 1, figs. 95–96; Cushman and Parker, 1947, p. 106, pl. 25, figs. 8–9; Asano, 1952, p. 11, text-figs. 57, 58.

Praeglobobulimina ovata (d'Orbigny). Haynes, 1954, p. 190, text-figs. 9–12, 17–19.

Protoglobobulimina ovata (d'Orbigny). Belford, 1966, p. 68, pl. 6, figs. 6–9.

Description.—Test free, triserial, consisting of two to three whorls, elongate, twice as long as broad, last whorl forming one-half or more of the test, circular in transverse section; chambers somewhat inflated, strongly overlapping previous ones; sutures distinct, slightly depressed, oblique; wall calcareous, hyaline, smooth, finely perforate; aperture loop-shaped, with a lip and distinct toothplate.

Discussion.—Belford (1966, pp. 67, 68) reviewed the three species *P. pupoides, P. ovata,* and *P. affinis* and placed them in the genus *Protoglobobulimina* Hofker, 1951. He based his recognition on the form of the toothplate, the position in relation to the septal foramen and attachment of the toothplate as well as the perforations of the wall. Loeblich and Tappan (1964a, p. C561) placed the genus *Protoglobobulimina* in synonymy with *Praeglobobulimina* Hofker, 1951, because they did not consider pore shape as a valid criterion for generic separation. In this study the rationale of Loeblich and Tappan (1964a) is followed.

There has been considerable confusion in the literature in differentiating the two species *ovata* and *pupoides*; thus a review of the internal character of the toothplate for individuals assigned to these two species is needed, as suggested by Belford (1966). According to Cushman and Parker (1947), *P. ovata* differs from *P. pupoides* in that the sutures curve downward rather than extending at right angles to the vertical axis.

Distribution.—*Praeglobobulimina ovata* was described from the Tertiary of the Vienna Basin. It is recorded from the Holocene of the Pacific and Mediterranean; Miocene-Pliocene of Papua New Guinea, Japan and East Indies. It is rare in the Concepcion and Encanto "biozones".

Praeglobobulimina spinescens (Brady, 1884)

Plate 21, figure 2

Bulimina pyrula d'Orbigny var. *spinescens* Brady, 1884, p. 400, pl. 50, figs. 11–12; Cushman, 1911, p. 78, text-fig. 128; Cushman and Parker, 1947, p. 124, pl. 28, figs. 30, 31.

Bulimina pyrula spinescens Brady. Asano, 1950, p. 4, text-fig. 17.

Praeglobobulimina spinescens (Brady). Hofker, 1951, p. 249, text-figs. 165–167; Belford, 1966, p. 73, pl. 6, figs. 19–21.

Globobulimina spinescens (Brady). Asano, 1958, p. 12, pl. 3, figs. 1, 2.

Description.—Test free, elongate, triserial with strongly-overlapping chambers, circular in transverse section, one-and-one-half times as long as broad, tapering at both ends; chambers inflated, increasing rapidly in size, highly involute, the last three chambers composing seven-eighths of the test, earlier chambers greatly reduced in size; sutures slightly depressed, narrow; wall calcareous, hyaline, ornamented by short spines projecting downward from the lower portion of the last three chambers, and the chambers of the earlier whorls; last one-third of the test imperforate, the remainder finely perforate; aperture elongate, narrow, extending from base of final chamber toward its apex, with a distinct lip and toothplate.

Discussion.—*Praeglobobulimina* differs from *Globobulimina* Cushman, 1927a, in possessing a toothplate with a fixed edge along the length of the aperture and generally less developed external fanlike projection (Pl. 21, figs. 2b, d).

Distribution.—*Praeglobobulimina spinescens* was described from the Holocene of the Pacific. It is recorded from the Pliocene and Miocene of Japan and Papua New Guinea, and Tertiary of Italy. It is rare and restricted to the lower Concepcion and Encanto "biozones."

Genus **STAINFORTHIA** Hofker, 1956

Stainforthia cf. **S. concava** (Höglund, 1947)

Plate 21, figures 4–5

Virgulina concava Höglund, 1947, p. 257, pl. 23, figs. 3–4, pl. 32, figs. 4–7, p. 257, text-figs. 273–274.

Description.—Test free, early stage triserial, later with twisted biserial stage, circular in transverse section, elongate, length three times the width, initial end pointed with one or two spines, test increasing in size gradually, greatest width near apertural end; chambers distinct, forming two to three whorls in biserial portion, increasing fairly rapidly in size, early chambers slightly inflated, later one greatly inflated, overlapping; sutures indistinct, depressed; wall calcareous, hyaline, smooth, finely perforate; aperture loop-shaped in face of ultimate chamber, toothplate with serrated curved portion protruding from aperture.

Discussion.—The internal structure of the toothplate and attachment to the previous chamber is shown in Plate 21, figure 5. The lower portion of the toothplate attached to the preceding chamber wall distinguishes *Stainforthia* Hofker, 1956, from *Buliminella* Cushman, 1911, which has the toothplate connecting to the previous aperture (Loeblich and Tappan, 1964a).

The specimens from the study area differ from *Stainforthia concava* (Höglund, 1947) in possessing a serrated toothplate that projects from the depression in the apertural face. *Stainforthia* cf. *S. concava* differs from *Stainforthia loeblichi* (Feyling-Hanssen, 1954) in possessing one or two spines on the initial end (for a discussion and synonymy of *S. loeblichi,* see Feyling-Hanssen *et al.,* 1971, p. 238).

Distribution.—*Stainforthia concava* was described from the Holocene of Sweden. *Stainforthia* cf. *S. concava* is rare to common in the Concepcion and Encanto "biozones".

Subfamily **PAVONININAE**
Eimer and Fickert, 1899

Genus **REUSSELLA** Galloway, 1933

Reussella pulchra Cushman, 1945
Plate 22, figure 1

Verneuilina spinulosa Reuss. Macfayden, 1930, p. 50, pl. 1, figs. 8a–b (not Reuss, 1850).
Reussella pulchra Cushman, 1945, p. 34, pl. 6, figs. 11–12; Marks, 1951, p. 61, pl. 7, fig. 15.

Description.—Test free, triserial throughout, triangular in transverse section, tricarinate, length almost one-and-one-half times the width, flaring rapidly from a pointed initial end, greatest width near apertural end; 15 chambers in five whorls, increasing fairly rapidly in size as added, each with one or more spines at the periphery; sutures distinct, limbate, raised and finely spinose, straight to slightly curved; wall calcareous, hyaline, coarsely perforate, with distinct large pores with raised rims, ornamented by short spines randomly distributed over the surface of each chamber, early portion of test spinose, almost obscuring the chambers, area immediately surrounding the aperture covered with short spines; aperture a low opening at base of ultimate chamber, with an internal toothplate.

Discussion.—Reussella pulchra possesses the well-developed pores with raised rims that also appear on *R. spinulosa* (Reuss, 1850) (Pl. 22, figs. 2d–e). *Reussella pulchra* can be distinguished from other species of *Reussella* by the spinose ornamentation on the raised sutures and chamber walls.

Distribution.—Reussella pulchra was described from the Miocene of the Vienna Basin. It is also reported from the Miocene of Egypt. This species is rare in the Encanto "biozone" occurring only at locality PD-68.

Reussella spinulosa (Reuss, 1850)
Plate 22, figure 2

Verneuilina spinulosa Reuss, 1850, p. 374, pl. 47, figs. 12a–c.
Reussella spinulosa (Reuss). Cushman, 1945, p. 33, pl. 6, figs. 8, 9; Renz, 1948, p. 156, pl. 7, figs. 16–17; Bermudez, 1949, p. 198, pl. 12, fig. 59; LeRoy, 1964, p. 34, pl. 3, fig. 19.

Description.—Test free, triserial throughout, triangular in transverse section, tricarinate, length one-and-one-half times the width, flaring rapidly from a pointed initial end, greatest width near apertural end; chambers distinct, numerous, 18 chambers in six whorls, increasing gradually in size as added, each with a well-developed spine at the periphery forming a serrated margin; sutures distinct, limbate, flush with surface, curved; wall calcareous, hyaline, smooth, except for small tubercles around the aperture, coarsely perforate; a distinct row of large pores with elevated rims ornament the chamber wall parallel to each suture, with an imperforate area in between; aperture a low opening at base of the ultimate chamber, with internal toothplate.

Discussion.—The specimens of *R. spinulosa* from this study show well-developed pores with raised rims (Pl. 22, figs. 2d–e). Similar pore development has been illustrated by Seibold (1975, pl. 4, fig. 6c) for an individual identified as *Reussella simplex* (Cushman, 1929b) from the Holocene of the Indian Ocean. Seibold (1975, p. 188) states that he has observed elevated pores in specimens of *R. pacifica* Cushman and McCulloch, 1948, and *R. atlantica* Cushman, 1947b, and postulates that this unique pore development may be characteristic of the entire genus.

Reussella miocenica Cushman, 1945, differs from *R. spinulosa* in the more elongate form, fewer chambers, and in the more coarsely serrate edge. *Reussella pulchra* Cushman, 1945, differs in its distinctly limbate, raised sutures, which are commonly spinose.

Distribution.—Reussella spinulosa was described from the Miocene of Vienna Basin. It is recorded from the Tertiary of Colombia, middle to late Miocene (Cercado Formation) of Dominican Republic, and middle to late Miocene (Pozon Formation) of Venezuela. It is rare in the Concepcion and Encanto "biozones".

Family **UVIGERINIDAE** Haeckel, 1894

Genus **RECTUVIGERINA** Mathews, 1945

Rectuvigerina basispinata
(Cushman and Jarvis, 1929)
Plate 22, figure 3

Siphogenerina basispinata Cushman and Jarvis, 1929, p. 13, pl. 3, figs. 4–5; Cushman and Stainforth, 1945, p. 49, pl. 8, fig. 3; Cushman and Renz, 1947, p. 29, pl. 7, fig. 1; Bermudez, 1949, p. 221, pl. 14, fig. 6.

Description.—Test free, elongate, early portion triserial, later portion uniserial, initial end acute with a well-developed spine, later uniserial portion with parallel sides, flattened at the apertural end; chambers obscured by ornamentation in the triserial portion, three distinct chambers in the uniserial portion comprising the latter one-half of the test, slightly inflated; sutures indistinct in the triserial portion, distinct and slightly depressed in the uniserial portion, perpendicular to the axis of growth; wall calcareous, hyaline, finely perforate, ornamented by 12 to 15 longitudinal platelike costae continuous over most of the chambers, breaking up into spinelike processes in the triserial portion, projecting downward from the base of the earlier chambers, initial chamber with well-formed spines; apertural terminal, at the end of a smooth cylindrical neck, centered in a slight depression in the ultimate chamber.

Discussion.—*Rectuvigerina basispinata* differs from *R. multicostata* (Cushman and Jarvis, 1929) in its less numerous longitudinal costae and in possessing a distinct spine on the initial end.

Distribution.—*Rectuvigerina basispinata* was described from Trinidad. It is recorded from the Oligo-Miocene (Cipero and St. Croix formations) of Trinidad, the middle Oligocene to early Miocene (Sombrerito Formation), and late Oligocene (Trinchera Formation) of the Dominican Republic.

It is rare in the study area, occurring only at locality SD-4 in the Encanto "biozone". Sansores and Flores-Covarrubias (1972b) report that *R. basispinata* is restricted to the middle Miocene (Deposito Formation) of the Salina Basin. The rare specimens occurring at locality SD-4 are probably reworked.

Rectuvigerina lamellata (Cushman, 1918)

Plate 22, figures 4–6

Siphogenerina lamellata Cushman, 1918b, p. 55, pl. 12, fig. 3; Cushman, 1930, p. 49, pl. 9, fig. 10; Cushman and Cahill, 1933, p. 28, pl. 9, fig. 4; Renz, 1948, p. 165, pl. 7, fig. 25; Bermudez, 1949, p. 221, pl. 14, figs. 9, 10; Drooger, 1953, p. 136, pl. 22, figs. 1, 2.

Rectuvigerina lamellata (Cushman). Mathews, 1945, p. 593, pl. 83, figs. 22, 23 (after Cushman, 1918b).

Description.—Test free, elongate, length two-and-one-half times the width, circular in transverse section; microspheric forms with early triserial portion, initial end sharply pointed, later becoming uniserial; megalospheric form uniserial throughout, initial portion broadly rounded, chambers distinct in megalospheric forms, nine to 12 in the adult, gradually increasing in size, slightly inflated, indistinct in triserial portion of microspheric form; sutures indistinct in triserial portion, distinct, slightly depressed and horizontal in uniserial portion; wall calcareous, hyaline, finely perforate, ornamented by seven to eight longitudinal platelike costae, continuing from initial end to midpoint of ultimate chamber, additional short costae inserted between the primary ones in microspheric forms; aperture terminal, ovate, with toothplate, a short neck and phialine lip.

Discussion.—The apertural toothplate is trough-shaped and connects successive apertures at an angle of 120° (see Pl. 22, figs. 5a–b).

Megalospheric forms are dominant in the study material. Microspheric forms are similar in size to megalospheric forms but have a sharply-pointed initial end and are more costate (Pl. 22, fig. 6).

Rectuvigerina lamellata differs from *R. transversa* (Cushman, 1918a) in possessing seven to eight longitudinal costae instead of 12, a greater length-to-width ratio, and higher, more bladelike costae.

Distribution.—*Rectuvigerina lamellata* was described from the Miocene (Choctawhatchee Formation) of Florida. It is recorded from the Neogene of Aruba and the Dominican Republic; Miocene (Cubagua, Carenero, San Lorenzo and Pozon formations) of Venezuela; early Miocene (St. Croix and Brasso formations) of Trinidad.

This species appears to be restricted to the Tertiary of the Gulf of Mexico–Caribbean areas. It is rare to common in the Concepcion and Encanto "biozones".

Genus **SIPHOUVIGERINA** Parr, 1950

Siphouvigerina auberiana (d'Orbigny, 1839)

Plate 22, figures 7–8; Plate 23, figure 1

Uvigerina auberiana d'Orbigny, *in* Sagra, 1839, p. 106 (pls. pub. separately), vol. 8, pl. 2, figs. 23–24; Cushman, 1923, p. 163, pl. 42, figs. 3, 4; Parker, 1958, p. 263, pl. 2, figs. 35–36; Uchio, 1960, p. 65, pl. 7, fig. 11; LeRoy and Levinson, 1974, p. 9, pl. 5, fig. 12.

Uvigerina proboscidea Schwager, 1866, p. 250, pl. 7, fig. 96; Cushman and Todd, 1945, p. 50, pl. 7, figs. 28a–b.

Uvigerina proboscidea Schwager var. *vadescens* Cushman, 1933b, p. 85, pl. 8, figs. 14–15.

Uvigerina pseudoampullacea Asano, 1938, p. 613, pl. 17, figs. 28–29.

Uvigerina auberiana d'Orbigny var. *attenuata* Cushman and Renz, 1941, p. 21, pl. 3, figs. 17a–b.

Uvigerina auberiana d'Orbigny var. *laevis* Goes. Phleger and Parker, 1951, p. 18, pl. 8, figs. 12–14 (not Goes, 1896).

Description.—Test free, initial portion triserial, later portion twisted biserial, elongate, circular in transverse section, initial end blunt and sometimes possessing a short spine; chambers inflated, broader than high, increasing fairly rapidly in first one-third of test, then increasing gradually in size, early chambers triserial and compact, later becoming twisted biserial and inflated; the last few chambers of some individuals are attenuated, the inner side of the ultimate chamber flattened with the neck of the penultimate chamber visible along the flattened side; sutures depressed, distinct on the later two-thirds of test; wall calcareous, hyaline, finely perforate, ornamented by small, sharp, closely-spaced spines, randomly arranged on chambers and neck; aperture terminal, at end of a long neck which has a phialine lip and an enrolled toothplate.

Discussion.—*Siphouvigerina auberiana* (d'Orbigny, 1839a) was considered to be distinct from *S. proboscidea* (Schwager, 1866) by Boersma (1974). In the present study, however, *S. proboscidea* is considered to be a junior synonym of *S. auberiana.* The writer has compared specimens of *S. proboscidea* from Car Nicobar with specimens of *S. auberiana* from the Caribbean, which are herein considered to be conspecific.

Siphouvigerina fusiformis (Galloway and Morrey, 1941) differs from *S. auberiana* in possessing spines aligned in vertical rows on the early portion of the test.

Siphouvigerina Parr, 1950, differs from *Uvigerina* d'Orbigny, 1826, in that the chambers in the adult are loosely attached and tend toward uniseriality, with sutures deeply incised (Loeblich and Tappan, 1964a, p. C571).

Distribution.—*Siphouvigerina auberiana* was described from the Holocene of the Caribbean Sea. It is recorded from the Holocene of the Atlantic, Pacific, Gulf of Mexico and Mediterranean Sea; and as *S. proboscidea* from the Neogene of Papua New Guinea and Car Nicobar; middle Pliocene (Mao Formation) of the Dominican Republic; late Miocene to early Pliocene (Bowden Formation) of Jamaica; and Neogene (Shimajiri Formation) of Okinawa. This species is rare in the Encanto "biozone".

Genus **TRIFARINA** Cushman, 1923

Trifarina cf. **T. fornasinii** (Selli, 1948)

Plate 23, figure 3

Angulogerina fornasinii Selli, 1948, p. 40, p. 43, text-figs. 1–4.

Description.—Test free, triserial, length twice the width, greatest width near center of test, triangular in transverse section, initial end broadly rounded; chambers inflated, overlapping, with weakly-developed costae on the lower half of test; three main costae developing at the angles of the test, transversing the last two chambers, terminating at the base of the neck; sutures indistinct, depressed, curved; wall calcareous, perforate, surface covered with small depressions or pits; aperture terminal, circular, at the end of a well-produced neck arising from the ultimate chamber, with a thick phialine lip and a toothplate.

Discussion.—The Mexican specimens of *Trifarina* cf. *T. fornasinii* have a more angular cross-section than the type figure of *T. fornasinii* (Selli, 1948). Individuals assigned to *Angulogerina fornasinii* Selli, 1948, in Agip Mineraria (1957, pl. 37) are similar to the Mexican forms.

Distribution.—*Trifarina fornasinii* (Selli) was described from the early Pliocene of Italy. *Trifarina* cf. *T. fornasinii* occurs in the study area only at locality SD-4 in the Encanto "biozone".

Trifarina rutila (Cushman and Todd, 1941)

Plate 23, figure 2

Uvigerina rutila Cushman and Todd, 1941, p. 78, pl. 20, figs. 16–22; Drooger, 1953, p. 136, pl. 21, figs. 29–30; Martinis, 1954, p. 121, pl. 7, fig. 6; Verdenius, 1970, p. 79, pl. 5, fig. 2.

Uvigerina rutila Cushman and Parker [*sic*]. Colom, 1946a, p. 162, pl. 10, figs. 152–154.

Trifarina holcki Akers and Dorman, 1964, p. 56, pl. 9, figs. 16–18; Poag and Valentine, 1976, p. 203, pl. 17, figs. 1–8, pl. 18, figs. 1–9, pl. 19, figs. 1–7.

Description.—Test free, triserial, small, fusiform, rounded triangular in section, greatest width near middle of test; chambers inflated, strongly overlapping; sutures distinct, depressed, strongly curved; wall calcareous, perforate, ornamented with numerous fine, discontinuous, longitudinal costae, interrupted at the sutures, occurring from initial end of test to base of neck; aperture a circular opening with phialine lip and toothplate, at end of short neck, arising from a flattened last chamber.

Discussion.—Paratypes of *Trifarina holcki* Akers and Dorman, 1964 were examined during the present study and observed to have costae restricted to each chamber, *i.e.,* not crossing the sutures. This is in agreement with the type description of *T. rutila.*

Distribution.—*Trifarina rutila* was described from the Pliocene of Algiers and Italy. It is recorded from the Pliocene of southern Spain, Romania and France; Neogene of Aruba; as *T. holcki* from the Pleistocene of the subsurface of Louisiana.

Trifarina rutila is rare in the study area, only occurring at locality PD-68 in the Encanto "biozone".

Genus **UVIGERINA** d'Orbigny, 1826

Uvigerina species A

Plate 24, figure 2

Description.–Test free, triserial, tending to become biserial in the adult, circular to ovate in transverse section, initial end bluntly rounded, length one-and-one-half times the width, widest at final one-third of the test; chambers inflated, broader than high, strongly embracing, ultimate and penultimate chambers added at approximately 150° to each other; sutures depressed, indistinct, obscured by overlapping chambers; wall calcareous, hyaline, finely perforate, ornamented by low, narrow, longitudinal costae, eight to 12 on each chamber, projecting below the basal margin but not crossing the suture, producing a scalloped appearance to the base of each chamber; aperture terminal, circular, with a toothplate and distinct thickened lip at end of a short neck at an angle to the longitudinal axis.

Discussion.—*Uvigerina* sp. A is variable in shape and ornamentation. The costae vary within a population. On some specimens, the costae may be absent on the upper portions of the ultimate and penultimate chambers. With others, the costae separate into shorter irregular segments near the apertural end.

There is a tendency for the triserial portion to approach a biserial arrangement in the adult. *Uvigerina* sp. A is similar to specimens assigned to the genus *Hopkinsina* Howe and Wallace, 1932, and may be a form transitional between *Uvigerina* and *Hopkinsina.*

Uvigerina cubana Hadley, 1934, from the Tertiary of Matanzas Province, northern Cuba, is similar in form but differs in having thicker costae and lacking the distinctive thickened lip of *Uvigerina* sp. A.

Uvigerina peregrina Cushman, 1923, is smaller than *U.* sp. A and has higher, bladelike costae.

Distribution.—Uvigerina sp. A is common in Pliocene sediments of the Louisiana and Texas continental shelf and in the lower Concepcion and Encanto "biozones".

Uvigerina charltonae Palmer, 1945

Plate 24, figure 1

Uvigerina charltonae Palmer, 1945, p. 49, pl. 1, figs. 3a–b.

Description.—Test free, triserial, elongate, ovate to subtriangular in transverse section, initial end angular, distal end flattened; chambers inflated, broader than high, increasing in size fairly rapidly as added, base of each chamber slightly overhanging the previous one; sutures depressed, distinct in the later chambers but obscured by ornamentation in the early stage; wall calcareous, hyaline, finely and densely perforate, ornamented by numerous costae, some of which continue from one chamber to another, the costae bladelike on the early portion of test, later portion with more numerous costae of varying length, width and height; aperture terminal, at end of short neck arising from a depression in the ultimate chamber, with a distinct toothplate.

Discussion.—Uvigerina charltonae is similar in shape to *Uvigerina laviculata* Coryell and Rivero, 1940, from the Tertiary of Haiti, but has coarse costae instead of fine striae.

Distribution.—Uvigerina charltonae was described from the late Miocene to early Pliocene (Bowden Formation) of Jamaica. It is rare in the study area, occurring only at locality PD-72 in the Encanto "biozone".

Uvigerina crassicostata Schwager, 1866

Plate 23, figures 4–5

Uvigerina crassicostata Schwager, 1866, pt. 2, p. 248, pl. 7, fig. 94; Cushman, 1934, p. 125, pl. 15, fig. 8; LeRoy, 1944b, p. 86, pl. 2, fig. 7; LeRoy, 1964, p. 35, pl. 4, fig. 1.
Uvigerina gallowayi Cushman, 1929a, p. 94, pl. 13, figs. 33–34.
Uvigerina barbatula Macfayden, 1930, p. 92, pl. 3, figs. 26a–b.
Uvigerina mexicana Nuttall, 1932, p. 22, pl. 5, figs. 12–13.
Euuvigerina crassicostata (Schwager). Belford, 1966, p. 79, pl. 7, figs. 17–20.

Description.—Test free, triserial, short in megalospheric form, microspheric form more elongate with pointed initial end, apertural end flattened in both forms; chambers slightly inflated, somewhat broader than high; sutures indistinct, curved, depressed; wall calcareous, perforate, in the megalospheric form ornamented by 18 or more high, platelike longitudinal costae that are continuous from one chamber to another, ultimate chamber generally smooth; aperture terminal, at end of short neck arising from a depression in the final chamber, with a distinct lip.

Discussion.—There are many species of *Uvigerina* which have longitudinal costae that are continuous from one chamber to the next, a smooth and flattened last chamber, and the neck situated in a depression. Many of these forms are conspecific.

Specimens of *U. crassicostata* from the Pliocene of Mexico and the subsurface Pliocene of Louisiana were compared to determine intraspecific variation. Variation in the number of costae, size, and shape of the test was observed. The microspheric forms from the present study are close to the type of Schwager, but the megalospheric forms are similar to *Uvigerina gallowayi* Cushman, 1929a. Dimorphism in *U. crassicostata* has resulted in many synonyms. Population studies are needed to compare the many additional species that fit the description of *U. crassicostata* Schwager, 1866.

Distribution.—Uvigerina crassicostata was described from the Pliocene of Car Nicobar. It is recorded from the Neogene of Java, Papua New Guinea, Fiji, Egypt, Venezuela; and the late Oligocene (Alazan Formation) of Mexico. This species is rare in the Encanto "biozone" only occurring at localities SD-4, PD-68 and 72.

Uvigerina hispida Schwager, 1866

Plate 24, figure 3; Plate 37, figure 4

Uvigerina hispida Schwager, 1866, p. 249, pl. 7, fig. 95; Kleinpell, 1938, p. 295, pl. 5, figs. 8–16; LeRoy, 1941b, p. 82, pl. 2, fig. 15; LeRoy and Levinson, 1974, p. 10, pl. 5, figs. 16, 17.
Uvigerina rustica Cushman and Edwards. Renz, 1948, p. 175, pl. 7, figs. 23–24 (not *U. rustica* Cushman and Edwards, 1938).
Euuvigerina hispida (Schwager). Belford, 1966, p. 78, pl. 7, fig. 14–16.

Description.—Test free, triserial, elongate, length one-and-one-half times to twice the width, rounded in transverse section, microspheric form with pointed initial end and a spine, megalospheric forms with broadly rounded initial end; chambers inflated, increasing in size rapidly; sutures indistinct, depressed; wall calcareous, perforate, ornamented by closely-spaced sharp-pointed spines; aperture terminal, at end of a short neck, with a phialine lip and an enrolled toothplate.

Discussion.—The spinose ornamentation of the specimens from the study area is distinctive. The spines on the later chambers are simple inverted cones, round in cross-section with a well-formed spine at the end (Pl. 37, fig. 4). Spines on the earlier chambers are more complex. They are composed of five to six spines radiating from the primary spine and at 90° to it. Others are a series of anastomosing rosettes (Pl. 24, figs. 3e–f). This unusual spinose morphology has not, to the writer's knowledge, been previously described.

Uvigerina hispida differs from *U. rustica* Cushman and Edwards, 1938, in possessing sharp rather than short, blunt spines or nodes. *Hopkinsina notohispida* Finlay, 1939, appears similar to *U. rustica.*

Uvigerina aculeata d'Orbigny, 1846, differs from *U. hispida* in possessing costae on the initial portion of the test.

Distribution.—*Uvigerina hispida* was described from the Pliocene of Car Nicobar. It is recorded from the Pleistocene of the Gulf of Mexico, Pliocene of Papua New Guinea; Miocene of California, Tertiary of Sumatra and Ecuador, Neogene (Shimajiri Formation) of Okinawa, and middle to late Miocene (Pozon Formation) of Venezuela. It is rare to common in the Encanto "biozone".

Uvigerina mantaensis Cushman and Edwards, 1938
Plate 24, figure 4

Uvigerina proboscidea Schwager. Galloway and Morrey, 1929, p. 39, pl. 6, fig. 4 (not *U. proboscidea* Schwager, 1866).

Uvigerina mantaensis Cushman and Edwards, 1938, p. 84, pl. 14, fig. 8; Galloway and Heminway, 1941, p. 430, pl. 33, fig. 7; Cushman and Stainforth, 1945, p. 47, pl. 7, fig. 17; Cushman and Stone, 1947, p. 17, pl. 2, fig. 26; Bermudez, 1949, p. 207, pl. 13, fig. 48; Becker and Dusenbury, 1958, p. 33, pl. 4, fig. 22; Todd and Low, 1976, p. 25, pl. 4, fig. 5.

Description.—Test free, triserial, length one-and-one-half times the width, greatest width near middle of test, ovate in transverse section, initial end rounded; chambers few, inflated, embracing, increasing rapidly in size; sutures indistinct in early portion, fairly distinct in later portion, slightly depressed; wall calcareous, perforate, ornamented with fine spines on some individuals, becoming smooth on others; aperture terminal, at end of a short, hispid neck with a phialine lip and toothplate.

Discussion.—*Uvigerina mantaensis* differs from *U. ecuadorensis* Cushman and Edwards, 1938, in its larger test and finely spinose ornamentation.

Distribution.—*Uvigerina mantaensis* was described from the Tertiary near Manta, Ecuador. It is recorded from the Neogene of Colombia and Dominican Republic, early Miocene (Ponce Formation) of Puerto Rico, Eocene (Chira Formation) of Peru, and Oligo-Miocene (Cipero Formation) of Trinidad. It is rare in the lower Concepcion and Encanto "biozones".

Uvigerina parvula Cushman, 1923
Plate 24, figures 5–6

Uvigerina peregrina Cushman var. *parvula,* Cushman, 1923, p. 168, pl. 42, fig. 11; Cushman and Jarvis, 1930, p. 363, pl. 33, fig. 11; Phleger and Parker, 1951 (part), p. 18, pl. 8, figs. 28–30 (not fig. 27).

Uvigerina peregrina Cushman forma *parvula* Cushman. Boltovskoy, 1959, p. 85, pl. 12, figs. 10–14; Poag, 1981, p. 87, pl. 27, figs. 3a–c, pl. 28, figs. 3a, b.

Uvigerina parvula Cushman. Andersen, 1961, p. 89, pl. 20, fig. 16; Bermudez and Seiglie, 1963, p. 189, pl. 18, fig. 7.

Uvigerina peregrina parvula Cushman. Akers and Dorman, 1964, p. 58, pl. 9, fig. 31.

Description.—Test free, triserial, small, last whorl loosely coiled, test elongate, approximately two-and-one-half times as long as broad; chambers inflated, embracing in first two-thirds of test, twice as broad as high, last chamber elongate; sutures indistinct, depressed; wall calcareous, perforate, ornamented by thin, low costae, restricted to each chamber, initial and final chamber may be spinose; aperture terminal at end of short, fragile, spinose neck, with phialine lip and toothplate.

Discussion.—*Uvigerina parvula* differs from *U. peregrina* Cushman, 1923, in its lower, more delicate costae, thinner test wall, more elongate test, and smaller size. According to Parker (1954) and Pflum and Frerichs (1976), *U. parvula* has a much shallower depth limit than *U. peregrina.*

Andersen (1961, p. 90) notes that the holotype of *U. parvula* was missing at the USNM when he was comparing types. Because of the poor type figure and description of Cushman (1923), many workers have relied upon Cushman and Jarvis' figure (1930, pl. 33, fig. 11) [D. Haman, oral commun., 1982].

Either a redescription of the holotype, if it exists, or designation of a neotype, is needed to standardize the diagnostic features of *U. parvula* sensu Cushman. Akers and Dorman (1964, p. 58) noted that several variants could be recognized on the basis of variability in the number and size of costae. Poag (1981) considered *U. parvula* to be an ecophenotypic variation of *U. peregrina,* as did Phleger and Parker (1951). A quantitative population study of the *U. parvula–U. peregrina* "morphoseries" is essential to better understand the variability of these taxa.

Distribution.—*Uvigerina parvula* was described from the Holocene of the Gulf of Mexico. It is recorded from the Holocene of the Caribbean and Atlantic, and the Pleistocene of the Gulf of Mexico. It is common to abundant in the Concepcion and Encanto "biozones".

Uvigerina peregrina Cushman, 1923
Plate 24, figure 7

Uvigerina peregrina Cushman, 1923, p. 166, pl. 42, figs. 7–10; Galloway and Wissler, 1927, p. 76, pl. 12, figs. 1, 2a–b; Phleger and Parker, 1951 (part), p. 18, pl. 8, figs. 22, 24, 25 (not fig. 26); Parker, 1958, p. 263, pl. 2, figs. 37, 38; Akers and Dorman, 1964, p. 58, pl. 9, fig. 26; Murray, 1971, p. 121, pl. 50, figs. 1–7; LeRoy and Levinson, 1974, p. 10, pl. 5, fig. 18.

Euuvigerina peregrina (Cushman). Belford, 1966 (part), p. 75, pl. 7, figs. 6, 7 (not figs. 3–5).

Description.—Test free, triserial, about two-and-one-half times as long as broad, widest near middle of test; chambers inflated, embracing; sutures depressed, indistinct; wall calcareous, perforate, ornamented by numerous high bladelike costae on each chamber, not continuing from one chamber to another, costae break up into spinose or irregular short segments toward apertural end; aperture circular at end of short neck, often spinose with a phialine lip and distinct toothplate visible in aperture.

Discussion.—The forms in the *U. peregrina–U. hispidocostata* group are considered to be conspecific by Smith (1964) and by Akers and Dorman (1964). There is a complete gradation of forms from completely costate to mostly hispid. My observations of uvigerinids from the subsurface Pleistocene of Louisiana suggest that the two species are phenotypic variations with their morphology controlled by water depth. According to Phleger and Parker (1951), the costate forms are generally shallower-water forms and the hispid, deeper-water forms.

C. W. Poag (written commun., 1982) examined types of *U. peregrina* at the USNM and reports that they all have fimbriate costae. However, the type description of *U. peregrina* Cushman, 1923 includes forms with "high and very thin and sharp costae, toward the base and apertural ends of the test becoming broken up into spinose or irregular short portions." Cushman's type description does not indicate that the costae are dominantly segmented or fimbriate. Poag (1981, pl. 27, fig. 1) figured a fimbriate specimen, which he called *U. peregrina* forma *typica,* but which in this writer's opinion more nearly fits *U. spinicostata* Cushman and Jarvis sensu Pflum and Frerichs (1976).

The concept of *U. peregrina* used herein would exclude the dominantly hispid or fimbriate forms although these may be the end members of the *U. peregrina–U. hispidocostata* morphoseries.

Drooger (1953, p. 133) and Belford (1966, p. 77), suggested that there should be population studies of the group to determine if the species represent different morphological stages. Because of current differences in criteria used for identification of the costate-hispid uvigerinids, I agree that a thorough study to standardize these criteria is imperative.

Distribution.—Uvigerina peregrina was described from the Holocene of the Atlantic. It is recorded from the Holocene of the Pacific, Gulf of Mexico, Mediterranean, and Caribbean; Pleistocene of the Gulf of Mexico and California; Pleistocene (Playa Grande and Mare formations) of Venezuela; Miocene (Choctawhatchee Formation) of Florida; Neogene of Papua New Guinea, and California. It is rare to abundant in the Concepcion and Encanto "biozones".

Superfamily **DISCORBACEA** Ehrenberg, 1838

Family **DISCORBIDAE** Ehrenberg, 1838

Subfamily **BAGGININAE** Cushman, 1927a

Genus **CANCRIS** Montfort, 1808

Cancris communis Cushman and Todd, 1942

Plate 25, figure 3

Cancris sagra (d'Orbigny) var. *communis* Cushman and Todd, 1942a, p. 79, pl. 19, figs. 8–11, pl. 20, fig. 1; LeRoy, 1944a, p. 36, pl. 3, figs. 10–12.

Cancris communis Cushman and Todd. LeRoy, 1964, p. 39, pl. 6, figs. 25, 26.

Description.—Test free, large, trochospiral, height one-and-one-half times the width, unequally biconvex, slightly convex on spiral side, highly convex on the umbilical side, periphery lobate, acute, with a distinct narrow keel; seven to eight chambers in the final whorl, all visible on the spiral side, increasing rapidly in size as added, inflated ventrally, lobate, the ultimate chamber making up over one-half the size of the test in side view; umbilical area closed by an umbilical flap projecting downward from the ultimate chamber; sutures distinct, strongly to slightly curved on the umbilical side, slightly depressed between the last two chambers, strongly depressed on the earlier ones and incised around the umbilical area, forming elevated lobes; wall calcareous, hyaline, smooth, finely perforate; aperture interiomarginal, umbilical-extraumbilical, extending from a point near the periphery to the umbilicus, which is covered by an umbilical flap.

Discussion.—Cancris communis differs from *Cancris sagra* (d'Orbigny, 1839a) in the larger size and the greater number of chambers in the final whorl (seven to eight).

Cancris auriculus (Fichtel and Moll, 1798) differs from *C. communis* in its coarsely-, rather than finely-perforate wall and in its smaller size.

Distribution.—Cancris communis was described from the Miocene (Shoal River and Choctawhatchee formations) of Florida. It is recorded from the Miocene of Sumatra, and Pliocene of Okinawa. *Cancris communis* is rare in the Concepcion and Encanto "biozones".

Genus **VALVULINERIA** Cushman, 1926c

Valvulineria mexicana Parker, 1954

Plate 25, figure 1

Valvulineria cf. *araucana* (d'Orbigny). Phleger and Parker, 1951, p. 25, pl. 13, figs. 7–8.

Valvulineria mexicana Parker, 1954, p. 526, pl. 9, figs. 1–3; Andersen, 1961, p. 104, pl. 23, fig. 1.

Valvulineria araucana (d'Orbigny). Uchio, 1960, pl. 8, figs. 3–5 (not *Rosalina araucana* d'Orbigny, 1839b).

Valvulineria glabra Cushman. Smith, 1964, p. 44, pl. 5, fig. 3 (not Cushman, 1927d).

Description.—Test free, medium size, biconvex, periphery broadly rounded, longer than broad in side view, slightly lobate; chambers distinct, seven to eight in the last whorl, increasing fairly rapidly in size as added, last few chambers inflated, especially those on the ventral side near the umbilicus; ultimate chamber with a broad imperforate flap extending over the umbilical area and covering umbilical flaps of previous chambers; sutures distinct, radial on the umbilical side, slightly curved on the spiral side, slightly depressed between the last few chambers on spiral and umbilical side, especially near the umbilicus; wall smooth, calcareous, hyaline, coarsely perforate except for the face of the ultimate chamber and the umbilical flap, which are imperforate; aperture interiomarginal, umbilical-extraumbilical, partially covered by a large projecting umbilical lip.

Discussion.—*Valvulineria sadonica* Asano, 1951, from the Pliocene of Japan, differs from *V. mexicana* in its much larger size and smaller umbilical flap.

Distribution.—*Valvulineria mexicana* was described from the Holocene of the Gulf of Mexico. It is recorded from the Holocene of the Pacific and Pleistocene of the Gulf of Mexico. This species is common in the upper and lower Concepcion "biozones" and rare in the Encanto "biozone".

Valvulineria nuttalli Palmer and Bermudez, 1936

Plate 25, figure 2

Cancris sagra (d'Orbigny). Nuttall, 1932, p. 27, pl. 6, figs. 6–7 (not *Rotalina sagra* d'Orbigny, 1839a).

Valvulineria nuttalli Palmer and Bermudez, 1936b, p. 300, pl. 19, figs. 3–5; Galloway and Heminway, 1941, p. 370, pl. 16, figs. 2a–c; Todd and Low, 1976, p. 25, pl. 5, figs. 11a–c.

Valvulineria inaequalis (d'Orbigny). Coryell and Rivero, 1940, p. 338, pl. 14, figs. 26a–c (not *Valvulina inaequalis* d'Orbigny, 1839b).

Description.—Test large, free, biconvex, oval in side view; narrowly elliptical in edge view; periphery rounded; about two whorls visible on spiral side, involute on the umbilical side with chambers terminating in slightly-elevated lobes around the umbilicus; chambers increasing rapidly in size, seven to eight in the last whorl; sutures narrow, slightly curved on spiral side, not depressed, radial on umbilical side, depressed near the umbilicus; wall smooth, calcareous, hyaline, finely perforate, except for last chamber, which has imperforate area adjacent to umbilicus; aperture interiomarginal, extraumbilical-umbilical with a broad, thin apertural flap extending from last chamber over the umbilicus.

Discussion.—*Valvulineria palmarealensis* (Nuttall, 1932) differs from *V. nuttalli* in its more oval outline in side view and in having more chambers in the final whorl.

Distribution.—*Valvulineria nuttalli* was described from the Tertiary of Matanzas Province, Cuba. It is recorded from the Tertiary of Haiti, late Oligocene (Alazan Formation) of Mexico, and Oligo-Miocene (Ponce and Juana Diaz formations) of Puerto Rico. It is rare in the lower Concepcion and Encanto "biozones".

Subfamily **DISCORBINAE** Ehrenberg, 1838

Genus **DISCORBINELLA**

Cushman and Martin, 1935

Discorbinella floridensis (Cushman, 1930)

Plate 25, figure 4

Discorbis bertheloti (d'Orbigny) var. *floridensis* Cushman, *in* Cushman and Jarvis, 1930, p. 364, pl. 33, figs. 13a–b; Cushman, 1931, p. 17, pl. 3, figs. 3–5; Cushman and Todd, 1945, p. 56, pl. 8, figs. 15–16.

Discorbis floridensis Cushman. Bermudez, 1949, p. 238, pl. 15, figs. 19–21; Phleger and Parker, 1951, p. 20, pl. 10, figs. 5–7.

Rosalina globularis d'Orbigny. Barker, 1960, p. 178, pl. 86, fig. 13 (not d'Orbigny, 1826).

Rosalina floridensis (Cushman). Poag, 1981, p. 81, pl. 41, fig. 2, pl. 42, fig. 2.

Description.—Test free, trochospiral, broad, large (1.0 mm), planoconvex to slightly concavoconvex; spiral side convex, nearly involute; umbilical side slightly concave, umbilicate but nearly involute; periphery keeled; chambers broad, the ultimate chamber comprising nearly one-half the test, four to five chambers in the last whorl, rapidly increasing in size as added, each chamber on the umbilical side with an angular projection over the umbilicus; sutures distinct, curved, depressed, slightly limbate on spiral side near periphery; wall calcareous, hyaline, smooth, finely and uniformly perforate on spiral side, umbilical side with only the outer margin of the chambers perforate; aperture a low, elongate, interiomarginal umbilical-extraumbilical arch on umbilical side, with supplemental openings formed by overlapping of umbilical flaps.

Discussion.—LeCalvez (1974, p. 59) photographed some topotypes of *Discorbinella bertheloti* (d'Orbigny, 1839c) using a scanning electron microscope. The illustrated specimens (LeCalvez, 1974, pl. 14) differ from *D. floridensis* (Cushman) in possessing a thinner keel, an aperture extending to the periphery, and a much smaller size. *Discorbinella bertheloti* has a greater number of chambers in the last whorl (six to eight) than *D. floridensis,* which has only four to five.

Distribution.—*Discorbinella floridensis* was described from the late Miocene to early Pliocene (Bowden Formation) of Jamaica. It is recorded from the Holocene of the Atlantic, Gulf of Mexico, and Caribbean; Neogene of Venezuela and Aruba; Miocene (Choctawhatchee Formation) of Florida; and late Miocene to early Pliocene (Gurabo Formation) of the Dominican Republic. It is rare at locality SD-4 in the Encanto "biozone".

Subfamily **ROSALININAE** Reiss, 1963

Genus **ROSALINA** d'Orbigny, 1826

Rosalina species A
Plate 25, figure 5

Description.—Test free, small (0.5 mm), trochospiral, concavoconvex, spiral side convex, umbilical side slightly concave with open umbilicus; subcircular in outline, slightly longer than broad, periphery lobate, margin acute with well-developed keel; six to seven chambers in the final whorl, increasing rapidly in size as added, ultimate chamber twice the size of the penultimate when viewed from umbilical side; sutures distinct, limbate, flush with surface on spiral side, slightly depressed between last few chambers on umbilical side; strongly curved on spiral side, radial on umbilical side; wall calcareous, hyaline, smooth, perforate, except for lower third of each chamber near the umbilicus, which is imperforate; aperture an interiomarginal, umbilical-extraumbilical arch, extending into the umbilicus under the umbilical flap that projects from the ultimate chamber.

Discussion.—*Rosalina* sp. A differs from *Discorbinella floridensis* (Cushman) in possessing an evolute spiral side, non-stellate umbilicus and a smaller size.

Distribution.—*Rosalina* sp. A is rare and occurs only in the upper and lower Concepcion "biozones".

Family **EPONIDIDAE** Hofker, 1951

Genus **CIBICORBIS** Hadley, 1934

Cibicorbis herricki Hadley, 1934
Plate 25, figure 6

Cibicorbis herricki Hadley, 1934, p. 26, pl. 5, figs. 1–3; Bermudez, 1949, p. 259, pl. 18, figs. 31–33.

Valvulineria collis Coryell and Rivero, 1940, p. 338, pl. 43, fig. 24.

Cibicides kugleri Cushman and Renz, 1941, p. 27, pl. 4, fig. 11.

Valvulineria herricki (Hadley). Cushman and Todd, 1945, p. 57, pl. 8, fig. 19; Akers and Dorman, 1964, p. 59, pl. 10, figs. 15, 17.

Description.—Test free, large, trochospiral, planoconvex, spiral side evolute and flattened, umbilical side convex and involute, periphery angular, lobate in side view; eight chambers in the final whorl, inflated, increasing rapidly in size, width greater than height, ultimate chamber triangular in edge view; sutures thick, raised and curved on spiral side, radial on umbilical side, flush on early portion, raised on later portion; wall smooth, calcareous, hyaline, coarsely perforate, except for the apertural face; aperture an interiomarginal slit on the umbilical side, extending from a point near the umbilicus to the periphery, with a large apertural flap projecting into the umbilicus.

Discussion.—*Cibicorbis* Hadley, 1934, differs from *Valvulineria* Cushman, 1926c, in possessing an angular rather than rounded periphery that the sutures do not cross.

Distribution.—*Cibicorbis herricki* was described from the Tertiary of Matanzas Province, Cuba. It is recorded from the Pleistocene of the Gulf of Mexico; Tertiary of Haiti, Cuba, and Venezuela; late Miocene to early Pliocene (Bowden Formation) of Jamaica; Oligo-Miocene (Sombrerito Formation) and middle Pliocene (Mao Formation) of the Dominican Republic. It is rare in the Encanto "biozone" occurring only at locality SD-4.

Genus **NEOEPONIDES** Reiss, 1960

Neoeponides parantillarum
(Galloway and Heminway, 1941)
Plate 25, figures 7–8

Eponides parantillarum Galloway and Heminway, 1941, p. 374, pl. 18, figs. 1a–c; Cushman and Todd, 1945, p. 58, pl. 9, figs. 6–7; Bermudez, 1949, p. 247, pl. 16, figs. 49–51; Todd and Low, 1976, p. 22, pl. 6, figs. 5a–c.

Neoeponides antillarum (d'Orbigny). Andersen, 1961, p. 102, pl. 23, figs. 4–5 (not *Rotalia* (*Rotalia*) *antillarum* d'Orbigny, 1839a).

Neoeponides parantillarum (Galloway and Heminway). Akers and Dorman, 1964, p. 44, pl. 10, figs. 38, 39; Belford, 1966, p. 118, pl. 17, figs. 13–15, pl. 18, figs. 1–3.

Description.—Test free, trochospiral, unequally biconvex, spiral side generally more convex than umbilical side, circular in side view; periphery subacute to rounded; seven to eight chambers in the last whorl, increasing gradually in size as added, early chambers on spiral side obscured by thickened calcite, only the chambers in last two whorls distinct; ultimate chamber extending along the keel to form a distinct projection; sutures on spiral side flush with surface, oblique; sutures on the umbilical side radial, flush near the periphery, limbate and raised near the umbilicus, becoming fused into a ring surrounding a deep umbilical depression; wall calcareous, hyaline, perforate, smooth, except for calcite deposits around the umbilicus; aperture an interiomarginal, umbilical-extraumbilical opening with a distinct thickened lip.

Discussion.—*Neoeponides parantillarum* differs from *Eponides antillarum* (d'Orbigny, 1839a) from the Holocene of the Caribbean, in its raised limbate sutures on the umbilical side, larger size, and non-limbate periphery in side view.

Distribution.—*Neoeponides parantillarum* was described from the Miocene (Quebradillas Formation) of Puerto Rico. It is also recorded from the Pleistocene of the Gulf of Mexico; Neogene of Papua New Guinea, Aruba, and Colombia; late Miocene to early Pliocene (Bowden Formation) of Jamaica; Miocene to Pleistocene (Playa Grande, Cubagua and Pozon formations) of Venezuela; Oligo-Miocene (Juana Diaz and Ponce formations) of Puerto Rico. This species is rare in the lower Concepcion and Encanto "biozones".

Family **LATICARININIDAE** Hofker, 1951

Genus **LATICARININA**
Galloway and Wissler, 1927

Laticarinina pauperata (Parker and Jones, 1865)
Plate 26, figure 1

Pulvinulina repanda Fichtel and Moll var. *menardii* d'Orbigny subvar. *pauperata* Parker and Jones, 1865, p. 395, pl. 16, figs. 50, 51a–b.

Pellatispira pauperata (Parker and Jones). Cushman, 1927d, p. 176, pl. 6, fig. 13.

Laticarinina pauperata (Parker and Jones). Cushman, 1931, p. 114, pl. 20, figs. 4a–c, pl. 21, figs. 1a–c; LeRoy, 1941a, p. 46, pl. 2, figs. 18–19; Renz, 1948, p. 143, pl. 10, fig. 4; Bermudez, 1949, p. 309, pl. 23, figs. 43–45; Agip Mineraria, 1957, pl. 50, figs. 8a–c; LeRoy, 1964, p. 44, pl. 9, fig. 25; Belford, 1966, p. 92, pl. 14, figs. 9–13.

Laticarinina halophora (Stache). Barker, 1960, p. 214, pl. 104, figs. 3–11 (not *Cristellaria* (*Robulina*) *halophora* Stache, 1865).

Description.—Test free, slightly trochoid, compressed, biconvex to planoconvex in edge view, spiral side flattened and evolute, ventral side convex and involute; periphery with a broad thin transparent keel, width almost equal to height of ultimate chamber; chambers inflated on ventral side, ten to 11 in the final whorl, early ones closely coiled, later ones loosely coiled; sutures radial, depressed on ventral side, flush on spiral side; wall calcareous, hyaline, smooth, finely perforate; primary aperture a narrow slit perpendicular to the periphery, at base of final chamber, secondary aperture beneath a flap, projecting from ultimate and penultimate chambers on spiral side into the central area.

Discussion.—Loeblich and Tappan (1964a, p. C580) state that individuals of the genus *Laticarinina* Galloway and Wissler, 1927, live unattached. Galloway (1933, p. 267) states that specimens of *Laticarinina* are either free or attached to plants. Cushman and Todd (1942b, p. 17) proposed that *L. pauperata* was attached to floating seaweeds and that this would explain its worldwide distribution. During the present study I could not find any documentation in the literature to support an attached habit for *L. pauperata.*

Distribution.—*Laticarinina pauperata* was described from the Holocene of the Atlantic. It is recorded from the Holocene of the Pacific, Gulf of Mexico, and Caribbean; Neogene of Papua New Guinea, Borneo and Siberoet Islands (East Indies), Mallorca, southern Spain, and Italy; middle to late Miocene (Pozon Formation) of Venezuela; late Oligocene (Trinchera Formation) of the Dominican Republic; and Neogene (Shimajiri Formation) of Okinawa. This species is rare in the Encanto "biozone" only occurring at localities PD-68 and SD-4.

Family **SIPHONINIDAE** Cushman, 1927a

Genus **SIPHONINA** Reuss, 1850

Siphonina pozonensis Cushman and Renz, 1941
Plate 26, figure 2

Siphonina pozonensis Cushman and Renz, 1941, p. 24, pl. 4, figs. 3a–c; Renz, 1948, p. 166, pl. 8, figs. 16a–c; Drooger, 1953, p. 139, pl. 24, fig. 11.

Description.—Test free, trochospiral, lenticular, unequally biconvex, periphery strongly keeled except in later portion, which is acute, slightly lobulate in outline; chambers slightly inflated, about five in the last whorl, those of the previous whorls obscured by calcite material on dorsal side; sutures oblique on the spiral side, radial to slightly curved on the umbilical side, slightly depressed between the last few chambers, keel somewhat fimbriate; wall calcareous, hyaline, coarsely perforate, smooth; aperture areal, elliptical, nearly equatorial, with short neck and phialine lip.

Discussion.—*Siphonina tenuicarinata* Cushman, 1927e, from the Tertiary of Mexico is a similar species but differs from *S. pozonensis* in possessing a much wider keel with pores that extend out from the edge of each chamber.

Siphonina pulchra Cushman, 1919, from the Tertiary of Cuba, differs from *S. pozonensis* in lacking the well-developed keel.

Distribution.—*Siphonina pozonensis* was described from the middle to late Miocene (Pozon Formation) of Venezuela. It is also recorded from the Miocene (San Lorenzo and Cubagua formations) of Venezuela, and from the Neogene of Aruba. This species is rare to common in the Concepcion and Encanto "biozones".

Family **AMPHISTEGINIDAE** Cushman, 1927a

Genus **AMPHISTEGINA** d'Orbigny, 1826

Amphistegina species A
Plate 26, figure 5

Description.—Test free, trochospiral, unequally biconvex, lenticular; umbilical side evolute and convex with umbo of clear calcite not extending above contour of test; spiral side involute and slightly convex to flattened with large umbo of clear calcite projecting well above the contour of test; periphery acute; final whorl with 15 to 17 chambers, increasing gradually in size as added; spiral side with chambers sharply curved and extending to margin of test, umbilical side with secondary chambers conspicuous and extending about halfway from the umbo to the periphery, projecting as a narrow irregular point between the lobes of the primary chambers, which curve strongly backwards; sutures fairly distinct on young specimens, flush with surface; wall calcareous, hyaline, chalky on large specimens, finely perforate, smooth; aperture a narrow slit at the inner margin of the last chamber on the umbilical side with a thin lip, surrounded by papillae.

Discussion.—This species is distinguished by the large prominent umbo of clear calcite on the flattened spiral side and the irregularly-shaped secondary chambers on the umbilical side.

Amphistegina bowdenensis Palmer, 1945, differs in its flattened umbilical side and possession of an umbo, on the spiral side, that does not project beyond the general contour of the test.

Distribution.—*Amphistegina* sp. A occurs in the study area only at locality SD-4 in the Encanto "biozone", where it is abundant.

Amphistegina gibbosa d'Orbigny, 1839
Plate 26, figures 3–4

Amphistegina gibbosa d'Orbigny, *in* Sagra, 1839, p. 120, pl. 8, figs. 1–3; Andersen, 1961, p. 111, pl. 24, figs. 6a–c; LeCalvez, 1977, p. 7; p. 6, figs. 1–5; Larsen, 1978, p. 225, pl. 3, figs. 1, 2, 4, 5, pl. 7, fig. 8; Poag, 1981, p. 41, pl. 47, fig. 2, pl. 48, figs. 2a–b.

Amphistegina lessonii d'Orbigny. Andersen, 1961, p. 111, pl. 24, figs. 1a–b; Akers and Dorman, 1964, p. 21, pl. 11, figs. 32, 33 (not d'Orbigny, 1826).

Description.—Test free, trochospiral, lenticular, unequally biconvex, umbilical side involute, spiral side evolute, circular in side view, periphery acute, spiral side with small calcite "plug"; chambers complex, 11 to 15 in final whorl, increasing in size gradually as added; spiral side with chambers sharply curved and extending to margin of test, partitioned by intersepta that project toward center of test; umbilical side with secondary chambers arranged in a star-shaped pattern and extending two-thirds the distance from the umbilicus to the periphery, with points between the lobes of the primary chambers extending to the peripheral margin; sutures flush, distinct in young specimens, less distinct in larger ones; wall calcareous, finely perforate, smooth; aperture a narrow slit at inner margin of last chamber on umbilical side, with thin lip surrounded by papillae.

Discussion.—According to Larsen (1977, p. 274), *Amphistegina gibbosa* d'Orbigny, 1839a, differs from *A. lessonii* d'Orbigny, 1826, in having more chambers (15 compared to 12) in the final whorl for equal-sized specimens. *Amphistegina gibbosa* is generally dextrally coiled while *A. lessonii* is generally sinistrally coiled (Larsen, 1978). Most specimens from the study area are dextral.

Distribution.—No type locality was given by d'Orbigny, but he observed *A. gibbosa* in Holocene sediments from Cuba, St. Thomas, and Jamaica. Larsen (1978) notes that *A. gibbosa* is restricted to the Holocene of the Atlantic–Caribbean region. It is also reported from the Pleistocene of the Gulf of Mexico, Pliocene of Italy, and late Pliocene of southern California (Crouch and Poag, 1979).

Because of the similarity between *A. gibbosa* and *A. lessonii,* many occurrences of *A. lessonii* mentioned in the literature could be *A. gibbosa. Amphistegina gibbosa* occurs in the upper Concepcion "biozone" and is less frequent in the Encanto "biozone" of the study area.

Family **CIBICIDIDAE** Cushman, 1927a

Subfamily **PLANULININAE** Bermudez, 1952

Genus **PLANULINA** d'Orbigny, 1826

Planulina ariminensis d'Orbigny, 1826
Plate 26, figure 6

Planulina ariminensis d'Orbigny, 1826, p. 280, pl. 14, figs. 1–3, 3a; Coryell and Rivero, 1940, p. 37, pl. 44, figs. 7a–c; Phleger and Parker, 1951, p. 32, pl. 18, figs. 4a–b; Redmond, 1953, p. 731, pl. 77, figs. 12a–b; Barker, 1960, p. 192, pl. 93, figs. 10–11; Verdenius, 1970, p. 81, pl. 7, fig. 1; LeRoy and Levinson, 1974, p. 12, pl. 6, figs. 11–13.

Description.—Test free, discoidal, low trochospiral, spiral side evolute, umbilical side partially evolute, circular in outline; periphery truncate, with thick marginal keel; chambers numerous, 10 to 12 in the final whorl, increasing gradually in size as added; sutures distinct, limbate, flush with surface, strongly curved on spiral and umbilical sides; wall calcareous, smooth, coarsely perforate; aperture an equatorial interiomarginal arch with a narrow lip, extending along the umbilical side beneath the margin of the last few chambers.

Discussion.—*Planulina ariminensis* is the type species for *Planulina* d'Orbigny, 1826. *Planulina exorna* Phleger and Parker, 1951, differs from *P. ariminensis* by having less curved sutures, a lobate outline, smaller size, and a rounded periphery.

Distribution.—*Planulina ariminensis* was described from the Holocene of the Adriatic Sea. It is recorded from the Holocene of the Atlantic, Gulf of Mexico and Mediterranean; Pleistocene of the Gulf of Mexico; Tertiary of southern Spain, Colombia, and Haiti. It is common in the lower Concepcion and Encanto "biozones".

Planulina exorna Phleger and Parker, 1951
Plate 26, figure 7

Planulina exorna Phleger and Parker, 1951, p. 32, pl. 18, figs. 5–7; Parker, 1954, p. 540, pl. 11, figs. 28–29; Akers and Dorman, 1964, p. 47, pl. 15, figs. 5–6; Schnitker, 1971, p. 206, pl. 9, fig. 6.

Description.—Test free, small, discoidal, low trochospiral, spiral side evolute, umbilical side partially evolute, lobate, in side view keeled, periphery subrounded;

nine to ten chambers in the last whorl, later chambers inflated on spiral side, umbilical flaps present on last three to four chambers; sutures distinct, limbate, curved on spiral and umbilical side, raised on early portion on spiral side with beadlike processes on sutures, later sutures becoming flush to depressed, sutures flush to depressed on umbilical side; wall calcareous, perforate, smooth on the umbilical side, ornamented by beads along the early sutures on the spiral side and a few of the early chambers; aperture an equatorial interiomarginal arch with a narrow lip extending onto the umbilical side, beneath the flaplike chamber margin.

Discussion.—*Planulina exorna* differs from *Planulina ariminensis* d'Orbigny, 1826, in its less curved sutures, smaller size, and less truncated periphery.

Distribution.—*Planulina exorna* was described from the Holocene of the Gulf of Mexico. It is also recorded from the Holocene of the Atlantic, and Pleistocene of the Gulf of Mexico. This species is abundant in the Encanto "biozone" at locality SD-4 and otherwise rare in the Concepcion and Encanto "biozones".

Subfamily **CIBICIDINAE** Cushman, 1927a

Genus **CIBICIDES** Montfort, 1808

Cibicides refulgens Montfort, 1808
Plate 27, figure 1

Cibicides refulgens Montfort, 1808, p. 123, text-fig. on p. 122; Cushman, 1931, p. 116, pl. 21, figs. 2a–c; Cushman and Gray, 1946, p. 45, pl. 8, figs. 15–17; Asano, 1951, p. 18, text-figs. 42–44; Todd and Brönnimann, 1957, p. 41, pl. 12, fig. 12; Barker, 1960, p. 190, pl. 92, figs. 7–9; Loeblich and Tappan, 1964a, p. C688, text-figs. 554, 1a–c.

Description.—Test attached, planoconvex, trochospiral, spiral side flat and evolute, umbilical side strongly convex and involute; periphery angular with thin imperforate keel; chambers numerous, seven to nine in the final whorl, all chambers visible from the attached spiral side, increasing fairly rapidly in size as added, last few inflated ventrally; sutures slightly depressed on the umbilical side and curved, on spiral side limbate, flush with surface and slightly curved; wall calcareous, hyaline, smooth, finely perforate, perforations large, widely spaced and few on the spiral side; apertural face imperforate; aperture a low interiomarginal opening, with a narrow lip, extending along the spiral suture on the spiral side.

Discussion.—*Cibicides lobatulus* (Walker and Jacob, 1798) differs from *C. refulgens* in its more lobulate periphery, coarser perforations on the umbilical side and its less convex umbilical side.

Distribution.—*Cibicides refulgens* is recorded from the Holocene of the Atlantic, Pacific, Caribbean; Pliocene of Japan and California; Miocene (Choctawhatchee Formation) of Florida and Neogene (Shimajiri Formation) of Okinawa. It is rare in the Encanto "biozone" of the study area.

Genus **DYOCIBICIDES**
Cushman and Valentine, 1930

Dyocibicides biserialis
Cushman and Valentine, 1930
Plate 27, figure 2

Dyocibicides biserialis Cushman and Valentine, 1930, p. 31, pl. 10, figs. 1–2; Cushman, 1930, p. 62, pl. 12, fig. 6; Cushman and Todd, 1945, p. 72, pl. 12, fig. 10; Asano, 1951, text-figs. 48–49; Barker, 1960, p. 192, pl. 93, fig. 6; Loeblich and Tappan, 1964a, p. C690, text-figs. 556, 1a–c.

Cibicides mckannai Galloway and Wissler var. *oranjestadensis* Drooger, 1953, p. 147, pl. 23, figs. 12–14.

Description.—Test attached, elongate, variable in shape, early stage trochospiral, attached by spiral side, later uncoiling and becoming irregularly biserial, periphery carinate, planoconvex, spiral side flat and evolute, ventral side convex and involute; chambers numerous, seven to eight in last whorl of coiled portion, all chambers visible from the spiral side, three to four pairs of chambers in the biserial portion, in coiled portion generally increasing gradually in size as added, inflated in biserial portion and increasing greatly in size as added; sutures in coiled portion limbate, flush with surface, radial to slightly curved, depressed on the ventral side of biserial portion, flush with surface on spiral side; wall calcareous, hyaline, coarsely perforate on the ventral side, imperforate on the spiral side; aperture an elongate slit at the outer edge of the ultimate chamber at the line of attachment.

Discussion.—Because of the sessile habit of *D. biserialis,* the form of the test is variable and dependent upon the substrate to which it is attached. The size, height and width of the chambers in the biserial portion is also variable as is the direction of growth.

Drooger (1953) described several new varieties of the species *Cibicides mckannai* Galloway and Wissler, 1927. *Cibicides mckannai* var. *oranjestadensis* Drooger, 1953, is considered, herein, to be conspecific with *D. biserialis* Cushman and Valentine. One other form, *C. mckannai* var. *arubana* Drooger, 1953, may be an ectophenotypic variant of *Dyocibicides biserialis.*

Distribution.—*Dyocibicides biserialis* was described from the Holocene. The type locality was not designated. It is recorded from the Holocene of the California coast, Pacific, Atlantic, Caribbean; Pleistocene and Pliocene of California; Pleistocene and Tertiary of Aruba; Pliocene and Miocene of Japan; late Miocene to early Pliocene (Bowden Formation) of Jamaica; Miocene (Choctawhatchee Formation) of Florida; Miocene to Pliocene (Mao and Gurabo formations) of the Dominican Republic; Miocene to Pleistocene (Playa

Grande, Mare and Cubagua formations) of Venezuela. This species is rare in the Concepcion and Encanto "biozones" occurring only at localities SD-29, PD-40, PD-54, and SD-4.

Genus **MONTFORTELLA**
Loeblich and Tappan, 1963

Montfortella bramlettei Loeblich and Tappan, 1963
Plate 27, figure 3

Monfortella bramlettei Loeblich and Tappan, 1963, p. 214, text-figs. 7–9; Kohl and Haman, 1980, p. 458, pl. 1, figs. 1–10.
Heterocibicides disjuncta McCulloch, 1977, p. 449, pl. 188, figs. 5–6.

Description.—Test attached, trochospiral, planoconvex to pseudo-acervuline, periphery carinate to subrounded, spiral side evolute, umbilical side involute; chambers numerous, variable in shape, six to eight in the final whorl, inflated, increasing fairly rapidly in size as added; sutures curved, limbate, and flush on spiral side, depressed, and radial on the umbilical side; slitlike intercameral opening between last three to four chambers on umbilical side, extending completely through test to spiral side; wall calcareous, hyaline, smooth, umbilical side coarsely perforate, spiral side generally imperforate; primary aperture an interiomarginal, equatorial arch, with thickened lip, extending onto the spiral side beneath apertural flaps of earlier chambers, secondary apertures on spiral side beneath imperforate flaps, opening along spiral suture, occasionally extending through test to intercameral slits on umbilical side.

Discussion.—The size and shape of the test is quite variable in *M. bramlettei.* Kohl and Haman (1980) note that *M. bramlettei* may have been attached to seaweeds and have assumed a "pseudo-acervuline" mode of growth. Other variable growth forms are probably a result of attachment to various substrates.

Haman (1978) in commenting on *Heterocibicides disjuncta* McCulloch, 1977, noted that *H. irregularis* McCulloch, 1977, is simply a morphologic variant of *M. bramlettei.*

Distribution.—Montfortella bramlettei was described from the Holocene of the California coast. It is also recorded from the Pleistocene (Santa Barbara Formation) of California, early Pliocene of Mexico, and as *Heterocibicides disjuncta* from the Holocene off the Galapagos Islands. It is rare in the Encanto "biozone" only occurring at localities SD-4 and PD-52.

Family **PLANORBULINIDAE** Schwager, 1877
Genus **PLANORBULINELLA** Cushman, 1927a

Planorbulinella larvata (Parker and Jones, 1865)
Plate 27, figure 4

Planorbulina vulgaris d'Orbigny var. *larvata* Parker and Jones, 1860 (*nom. nud.*), p. 294.
Planorbulina larvata Parker and Jones, 1865, p. 379, pl. 19, figs. 3a–b.
Planorbulinella larvata (Parker and Jones). Galloway and Heminway, 1941, p. 403, pl. 26, figs. 5a–c; Bermudez, 1949, p. 311, pl. 26, figs. 42–43; Barker, 1960, p. 190, pl. 92, figs. 5–6; Loeblich and Tappan, 1964a, p. C694, text-figs. 563, 1–2; Thomas, 1977, p. 190, pl. 1, figs. 1–2.
Planorbulinella cf. *larvata* (Parker and Jones). Cushman and Todd, 1945, p. 73, pl. 12, fig. 12.

Description.—Test attached, subdiscoidal, more flattened on attached spiral side, trochoid in early stage, later developing an annular series of chambers, periphery rounded; chambers numerous, all visible on the spiral side, inflated, early trochoid portion small, later chambers alternating with the chambers of the previous whorl, central chambers on the ventral side covered by small elongate knobs obscuring all but the outermost whorl, chambers in the outer whorl greatly inflated, forming a lobate periphery; sutures indistinct on ventral side, flush with surface on spiral side; wall calcareous, hyaline, fairly smooth on the spiral side, ventral side covered by irregular, small, elongate knobs and granules, coarsely perforate; apertures oval, two to each chamber at the ends of the chamber, each with a narrow bordering lip, visible on chambers of the last whorl.

Discussion.—Cushman (1927a) chose this form as the type species for *Planorbulinella.* All of the specimens occurring in the Mexican material are broken, usually lacking a complete outer whorl.

Distribution.—Planorbulinella larvata was described from the Holocene of the Indian Ocean. It is recorded from the Holocene of the Pacific and Gulf of Aqaba, late Miocene to early Pliocene (Bowden Formation) of Jamaica, the Miocene to Pliocene (Gurabo Formation) of the Dominican Republic, and early Miocene (Ponce Formation) of Puerto Rico. It is rare in the Encanto "biozone" only occurring at locality SD-4.

Family **HOMOTREMATIDAE** Cushman, 1927a

Subfamily **VICTORIELLINAE**
Chapman and Crespin, 1930

Genus **CARPENTERIA** Gray, 1858

Carpenteria balaniformis Gray, 1858
Plate 27, figure 5

Carpenteria balaniformis Gray, 1858, p. 269, p. 268, text-figs. 1–4; Loeblich and Tappan, 1964a, p. C707, text-figs. 580, 1a–c.
Carpenteria balaniformis Gray (?). Barker, 1960, p. 202, pl. 98, figs. 14, 17.

Description.—Test attached, planoconvex to concavoconvex, trochospiral, spiral side flat and evolute, umbilical side strongly convex, conical and involute, periphery angular with a thin imperforate keel; chambers numerous, increasing rapidly in size as added, five to six in the final whorl, all chambers visible on the attached spiral side; deeply umbilical, with chamber flaps projecting into open umbilicus; sutures indistinct on umbilical side, distinct and flush with surface on spiral side; wall calcareous, hyaline, smooth, umbilical side coarsely perforate, apertural face, umbilical area, and spiral side imperforate; aperture slitlike, extending from the periphery along the base of ultimate chamber into the open umbilicus.

Discussion.—*Carpenteria truncata* (Bermudez, 1949) from the Sombrerito Formation of the Dominican Republic, differs from *C. balaniformis* in possessing more chambers in the last whorl and in having the umbilical region filled with transparent shell material.

Loeblich and Tappan (1964a, p. C708) state that Gray's types from the Philippine Islands are not preserved. The redefinition of *Carpenteria* Gray, 1858, was based on the type species as shown by a specimen figured by Chapman (1900) and redrawn by Loeblich and Tappan (1964a, text-figs. 580, 1a–c).

Distribution.—*Carpenteria balaniformis* was described from the Holocene of the Philippine Islands. It is also recorded from the Holocene of the Atlantic Ocean. This species is rare to common in the Encanto "biozone" at locality SD-4.

Superfamily **ROTALIACEA** Ehrenberg, 1839

Family **ROTALIIDAE** Ehrenberg, 1839

Subfamily **ROTALIINAE** Ehrenberg, 1839

Genus **AMMONIA** Brünnich, 1772

Ammonia parkinsoniana (d'Orbigny, 1839)

Plate 28, figure 4

Rosalina parkinsoniana d'Orbigny, *in* Sagra 1839, p. 99, pl. 4, figs. 25–27.

Rotalia beccarii (Linnaeus). Cushman, 1931 (part), p. 58, pl. 12, figs. 1–2, pl. 13, figs. 1–2 (not pl. 12, figs. 3–7) (not *Nautilus beccarii* Linnaeus, 1758).

Ammonia beccarii (Linné) forma 2, Matoba, 1970 (part), p. 48, pl. 5, figs. 11a–c (not figs. 10a–c, 12a–c).

Ammonia parkinsoniana (d'Orbigny). LeCalvez, 1977, p. 92, figs. 1–3, 25–27.

Ammonia parkinsoniana (d'Orbigny) forma *typica* Poag, 1978 (part), p. 397, pl. 1, figs. 8, 9, 13–16, 19–21 (not figs. 5–7).

Description.—Test free, trochospiral, biconvex, circular in side view and slightly lobate, periphery broadly rounded; spiral side evolute; umbilical side involute with a broad open umbilicus and a small umbilical plug; chambers inflated, eight to nine in the final whorl, increasing gradually in size as added, last few chambers with an extension into the open umbilicus around the umbilical plug; sutures distinct, radial to slightly oblique and flush on the spiral side, radial on the umbilical side and incised as suture approaches umbilicus; wall calcareous, hyaline, smooth, finely perforate except for the inner one-third of the chambers near the umbilicus; aperture an interiomarginal, extraumbilical-umbilical slit, continuing to the umbilicus under the projection of the ultimate chamber.

Discussion.—According to Poag (1978), *Ammonia beccarii* (Linné) described from beach sands of Rimini, Italy, is restricted to the Mediterranean and eastern Atlantic Ocean. None of the western Atlantic occurrences are "true" *A. beccarii.* Poag (p. 401) states that "*A. beccarii* has one distinctive and persistent feature—a presence of rows of short ribs or beads and furrows along the sutures of the umbilical side".

Specimens of *Ammonia parkinsoniana* (d'Orbigny) from the Pliocene of Mexico, herein, differ from those figured by Poag (1978) in not possessing the raised sutures on the dorsal side.

Distribution.—*Ammonia parkinsoniana* is widely distributed. It occurs in the Holocene of the Gulf of Mexico, Caribbean, Atlantic, and Pacific Oceans. *Ammonia parkinsoniana* is common in the shallow water facies of the upper Concepcion "biozone" in the study area.

Ammonia tepida (Cushman, 1926)

Plate 28, figure 3

Rotalia beccarii (Linnaeus) var. *tepida* Cushman, 1926d, p. 79, pl. 1; Cushman, 1931, p. 61, pl. 13, figs. 3a–c; Agip Mineraria, 1957, pl. 41, fig. 6.

Rotalia beccarii (Linné) variant C, Parker, Phleger, and Pierson, 1953, p. 13, pl. 4, figs. 29–30.

Streblus beccarii (Linné) var. *tepida* (Cushman). Todd and Brönnimann, 1957, p. 33, pl. 10, figs. 5–11.

Streblus beccarii tepida (Cushman). Andersen, 1961, p. 99, pl. 22, fig. 2.

Ammonia parkinsoniana (d'Orbigny) forma *tepida* Poag, 1978, p. 397, pl. 1, figs. 1–4, 10–12.

Description.—Test free, trochospiral, unequally biconvex, circular in outline and slightly lobate, periphery broadly rounded; spiral side evolute and more convex than umbilical side, umbilical side involute with broad, open umbilicus; chambers inflated, six to eight in the last whorl, increasing gradually in size as added, each chamber with an extension projecting into the open umbilicus, leaving angular open spaces between projections; sutures distinct, limbate, oblique, and slightly raised on the spiral side, depressed in the last whorl; sutures on the umbilical side depressed and slightly oblique; wall calcareous, hyaline, smooth, finely perforate; aperture an interiomarginal, umbilical-extraumbilical opening extending into the umbilicus.

Discussion.—*Ammonia tepida* (Cushman, 1926d) differs from *A. parkinsoniana* (d'Orbigny, 1839a) in possessing an open umbilicus that lacks an umbilical plug.

Poag (1978), in his work with Recent benthic foraminifers of San Antonio Bay, proposed that *A. parkinsoniana* and *A. tepida* are ecophenotypic pairs—members of a morphoseries. He established *A. parkinsoniana* forma *typica* for large individuals with an umbilical plug and *A. parkinsoniana* forma *tepida* for smaller forms without a plug.

The morphoseries of *A. parkinsoniana* described by Poag (1978) was not found in a study of Recent benthic foraminifers of the Mississippi River Delta (Haman, written commun., 1982). Haman did not find stages transitional between *A. parkinsoniana* and *A. tepida* and therefore regards these forms as distinct species. According to Haman not only do they occur in the same environmental regimes in the Delta, but in a large number of cases, the two species occur in the same sampling locality.

Since transitional forms are not present in the populations of *Ammonia* in this study, I follow the rationale of Haman and consider *A. tepida* and *A. parkinsoniana* to be distinct species.

It is apparent that a comparison of clonal and *in situ* living populations of *Ammonia* from the Gulf of Mexico is needed. This study could show the variability of morphology as a factor of salinity and temperature, etc.

Schnitker (1974) reported on clonal cultures of *Ammonia* from the north Atlantic (Maine to North Carolina). His studies examined the temperature dependence of several populations: he concluded that only one species was present. Gulf of Mexico populations of *Ammonia,* however, live in areas of wide fluctuation of temperature and salinity. Effects of changes in these parameters on morphology could assist in determining the validity of Poag's 1978 hypothesis that *A. tepida* is an ecophenotypic variant of *A. parkinsoniana.*

Distribution.—*Ammonia tepida* is recorded from the Holocene of the Gulf of Mexico, Caribbean, and Atlantic oceans; Pleistocene of the Gulf of Mexico. It is rare in shallow water facies of the upper Concepcion "biozone" of the study area.

Genus **DISCORBIS** Lamarck, 1804

Discorbis? olutensis, new species

Plate 28, figures 1–2; Plate 37, figures 2–3

Etymology of name.—Named for the village of Oluta in the State of Veracruz, Mexico (Text-fig. 9).

Description.—Test free, trochospiral, biconvex, circular in side view; periphery keeled, slightly lobate; seven to eight chambers in the final whorl, increasing gradually in size as added, slightly inflated on umbilical side; all chambers visible on spiral side; umbilical side with an umbilical "plug" covered by pustulose material; sutures distinct, slightly depressed on umbilical side, flush with surface on spiral side; wall calcareous, perforate, smooth, except for an elevated pustulose area in the umbilical region that covers the proximal portion of early chambers; primary aperture interiomarginal, between umbilicus and periphery, bordered by a thin lip; supplemental apertures developed on umbilical side, at the proximal end of each of the last three chambers, under a small backward-projecting flap that opens into a canal along the suture between the umbilical "plug" and chamber margin.

Diagnosis.—This species is characterized by the transparent spiral side with gently-curved sutures and by a pustulose umbilical plug and nearly-radial sutures on the umbilical side (Pl. 28, figs. 1–2).

Discussion.—Because of the poor type figure of Lamarck (1804), many unrelated taxa have been placed in the genus *Discorbis.* Cushman (1927g) illstrated a topotype specimen but even this figure was incomplete. Most texts copied either the original figure of *Discorbis* or the misleading illustrations from Cushman (Loeblich and Tappan, 1964a, p. C574). The true concept of *Discorbis* sensu Lamarck has been greatly confused.

In their definition and discussion of *Discorbis,* Loeblich and Tappan (1964a) considered as diagnostic the following features of the genus: 1) an umbilical flap separating the supplementary apertures; 2) an umbilical plug; and 3) channelled ventral sutures. They placed *Rotorbinella* Bandy, 1944, and *Biapertorbis* Pokorny, 1956, in synonymy with *Discorbis.*

However, Douglas and Sliter (1965) considered *Rotorbinella* Bandy distinct from *Discorbis* Lamarck because it possesses a solid central "column" with a knob or boss and a thickened, high-domed spiral side. They regarded *Biapertorbis* Pokorny as a junior synonym of *Rotorbinella.*

Discorbis? *olutensis* does not possess the solid umbilical plug of *Rotorbinella* sensu Douglas and Sliter (1965) nor the channelled ventral sutures and the pronounced umbilical flap of *Discorbis* sensu Loeblich and Tappan (1964a). This species does, however, possess supplemental apertures opening into the umbilicus, an umbilical plug and the slight projecting umbilical flap of *Discorbis* (Pl. 37, figs. 2–3). It appears that *D.*? *olutensis* more nearly fits the concept of *Discorbis* and therefore this species is placed provisionally within that genus.

Discorbis? *olutensis* lacks the amorphous material along the umbilical sutures and the posteriorly-located slitlike sutural aperture of the genus *Buccella* Andersen, 1952.

Types.—Holotype: USNM 400653; paratypes: USNM 400654; 400655; 400656.

Measurements.—Diameter of test: 0.31–0.45 mm, thickness: 0.15–0.21 mm.

Type locality.—Locality SD-4 (holotype), Sayula Dome, 4.5 km south of Acayucan along Highway #185, PD-35 (paratypes), Potrerillos Dome, south side of Mexican Highway #180, 16 km east of Acayucan, State of Veracruz, Mexico. In the Encanto "biozone" (N.19), early Pliocene.

Other localities.—*Discorbis*? *olutensis* is common in the Pliocene of the subsurface continental shelf of Louisiana and Texas. It is also common in the Concepcion and Encanto "biozones" of the study area.

Family **ELPHIDIIDAE** Galloway, 1933

Subfamily **ELPHIDIINAE** Galloway, 1933

Genus **ELPHIDIUM** Montfort, 1808

Elphidium advenum (Cushman, 1922)

Plate 28, figure 5

Polystomella advena Cushman, 1922d, p. 56, pl. 9, figs. 11–12.

Elphidium advenum (Cushman). Cushman and Cahill, 1933, p. 22, pl. 7, figs. 10a–b; Cushman, 1939, p. 60, pl. 16, figs. 31–35; Bermudez, 1949, p. 167, pl. 11, fig. 35; Marks, 1951, p. 51, pl. 6, figs. 9–10; Barker, 1960, p. 226, pl. 110, figs. 1a–b; Schnitker, 1971, p. 198, pl. 7, figs. 2a–b; Hansen and Lykke-Andersen, 1976, p. 7, pl. 2, fig. 10, pl. 3, fig. 1.

Description.—Test free, planispiral, bilaterally symmetrical, involute, slightly compressed; periphery acute to subacute, narrowly keeled, slightly lobulate; umbilical area depressed with a central boss, numerous retral processes along septal border; chambers distinct, about 14 to 15 in the final whorl, slightly inflated, increasing in size gradually as added, retral processes about one-fourth the width of a chamber, approximately six to seven retral processes per chamber, gradually increasing in width toward the periphery; sutures depressed, slightly curved to radial, obscured by retral processes; wall calcareous, hyaline, smooth, finely perforate; aperture a series of small pores at base of septal face, earlier chambers with areal pores.

Discussion.—Marks (1951, p. 51) considered *E. advenum* to be an intermediate form between *E. ungeri* (Reuss, 1850) and *E. flexuosum* (d'Orbigny, 1846) because of the size of the "umbonate disc" and the number of chambers.

Hansen and Lykke-Andersen (1976) determined that the presence of retral processes is a character of degree and cannot be used for classification. They studied the topotypes of *Cribroelphidum vadescens* Cushman and Brönnimann, 1948 (the type species for *Cribroelphidium* Cushman and Brönnimann, 1948) and observed that the specimens "showed no areal apertures". Todd and Brönnimann (1957, pl. 7, figs. 10–11) illustrated two specimens of *C. vadescens,* only one of which has areal pores. They assigned both specimens to the genus *Elphidium* Montfort, 1808.

Hansen and Lykke-Andersen (1976, p. 28) concluded that *Cribroelphidium* "may or may not have additional areal apertures". They placed *Cribroelphidium* in synonymy with *Elphidium.* This rationale is followed herein.

Distribution.—*Elphidium advenum* was described from the Holocene of the Tortugas region of southern Florida. It is a widely-distributed species recorded from the Holocene of the Atlantic, Pacific, Caribbean, and Gulf of Mexico; Tertiary of Cuba, Italy, and the Vienna Basin; Pliocene (Jimani Formation) of the Dominican Republic; Miocene (Choctawhatchee and Chipola formations) of Florida. It is common in shallow water facies of the upper Concepcion "biozone" (locality SD-29) and rare in the deeper water lower Concepcion and Encanto "biozones".

Elphidium incertum (Williamson, 1858)

Plate 28, figure 6

Polystomella umbilicata (Walker) var. *incerta* Williamson, 1858, p. 44, pl. 3, fig. 82a.

Elphidium incertum incertum (Williamson). Feyling-Hanssen, 1964, p. 344, pl. 19, figs. 16, 17, pl. 20, figs. 9, 10.

Elphidium incertum (Williamson). Feyling-Hanssen *et al.,* 1971, p. 277, pl. 12, figs. 11, 12, pl. 21, figs. 8, 9; Hansen and Lykke-Andersen, 1976, p. 15, pl. 12, figs. 5–9.

Description.—Test free, planispiral, bilaterally symmetrical, involute, slightly compressed, slightly lobate in side view; periphery rounded to subacute; umbilical area depressed and filled with fine tuberculations and calcite deposits; chambers distinct, about 11 to 12 in the final whorl, inflated, increasing in size gradually as added; retral processes irregular, more developed on the last few chambers near the periphery, earlier chambers and umbilicus with long radiating grooves and elongate pits parallel to the septal line; sutures curved, depressed, obscured by retral processes; wall calcareous, hyaline, finely perforate, smooth except for fine tuberculation in the umbilicus and along the ventral edge of the last few chambers; aperture a series of small pores at the base of the septal face, earlier chambers lack areal pores.

Discussion.—There have been many misidentifications of this species, and Loeblich and Tappan (1953, p. 101) give a detailed account of the errors in the literature. Many of these errors are credited to Cushman, and for this reason Cushman's references are omitted from the synonymy. For additional remarks the reader is referred to Loeblich and Tappan (1953).

Distribution.—*Elphidium incertum* was described from the Holocene of the North Sea. It is recorded from the Holocene of the Atlantic and Pacific oceans, and the Miocene (Choctawhatchee Formation) of Florida. It is common in shallow water facies of the upper Concepcion "biozone" and rare in the lower Concepcion "biozone" of the study area.

Elphidium poeyanum (d'Orbigny, 1839)
Plate 28, figure 7

Polystomella poeyana d'Orbigny, *in* Sagra, 1839, p. 55, pl. 6, figs. 25–26 (plates published separately).

Elphidium poeyanum (d'Orbigny). Cushman and Cahill, 1933, p. 21, pl. 7, figs. 7a–b; Cushman, 1939, p. 54, pl. 14, figs. 25–26; Galloway and Heminway, 1941, p. 363, pl. 14, figs. 6a–b; Hansen and Lykke-Andersen, 1976, p. 13, pl. 9, figs. 9–12, pl. 10, figs. 1–5.

Elphidiononion poeyanum (d'Orbigny). Barker, 1960, p. 226, pl. 109, fig. 22a.

Cribroelphidium poeyanum (d'Orbigny). Loeblich and Tappan, 1964a, p. C635, figs. 508, 3a–b.

Description.—Test free, planispiral, bilaterally symmetrical, involute, slightly compressed; periphery rounded; circular in side view; umbilical area depressed; numerous retral processes along the septal border; chambers distinct, embracing, about eight to nine chambers in the final whorl, slightly inflated, increasing in size gradually as added, retral processes regular, usually six to seven septal bridges between the ultimate and penultimate chambers; sutures indistinct, slightly depressed, obscured by retral processes; wall calcareous, hyaline, perforate, except for imperforate apertural face, smooth; aperture a series of small pores at the base of the septal face and several areal pores.

Discussion.—Elphidium poeyanum was selected by Hofker (1951) as the type species for *Elphidiononion* Hofker, 1951. Loeblich and Tappan (1964a, p. C635) consider *Elphidiononion* to be a junior synonym of *Cribroelphidium* Cushman and Brönnimann, 1948. Hansen and Lykke-Andersen (1976) placed *Cribroelphidium* in synonymy with *Elphidium* Montfort, 1808. For an additional discussion the reader is referred to the Discussion section of *E. advenum* herein.

Distribution.—Elphidium poeyanum was described from the Holocene of the Caribbean. It is recorded from the Holocene of the West Indies, Gulf of Mexico, Atlantic, and Pacific; Pleistocene of the Gulf of Mexico; Miocene (Chipola and Choctawhatchee formations) of Florida; Miocene to Pleistocene (Pozon, Playa Grande and Mare formations) of Venezuela; Tertiary of Puerto Rico. It is rare to common in the Concepcion "biozone" of the study area.

Superfamily **CASSIDULINACEA**
d'Orbigny, 1839b

Family **CAUCASINIDAE** Bykova, 1959

Subfamily **FURSENKOININAE**
Loeblich and Tappan, 1961

Genus **FURSENKOINA**
Loeblich and Tappan, 1961

Fursenkoina bramlettei
(Galloway and Morrey, 1929)
Plate 29, figure 1

Virgulina bramlettei Galloway and Morrey, 1929, p. 37, pl. 5, figs. 14a–b; Cushman and Moyer, 1930, p. 57, pl. 8, fig. 2; Cushman, 1937c, p. 19, pl. 3, figs. 6–9.

Description.—Test free, elongate, biserial, subcylindrical, slightly compressed, ovate in transverse section, length four times the width; chambers distinct, inflated, four to five pairs in a twisted biserial arrangement, last three pairs of chambers making up three-fourths of the test; sutures distinct, slightly depressed; wall calcareous, hyaline, finely perforate, smooth, initial chamber ornamented with a short spine; apertural terminal, a narrow opening with a raised margin on one side and a distinct toothplate.

Discussion.—Galloway and Morrey (1929) described *F. bramlettei* as possessing a triserial early stage. Loeblich and Tappan (1964a, p. C731) commented that numerous references "have erroneously stated that *Virgulina = Fursenkoina* has a triserial base". They examined topotypes of *V. squammosa* d'Orbigny, 1826, and observed only a highly-twisted biserial development.

Distribution.—Fursenkoina bramlettei was described from the Tertiary of Ecuador. It is also recorded from the Holocene off California, Tertiary of Cuba, and Oligo-Miocene (Meson Formation) of Mexico.

This species is rare in the study area, occurring at localities PD-40 and PD-49 in the Concepcion "biozone" and locality PD-35 in the Encanto "biozone".

Fursenkoina pontoni (Cushman, 1932)
Plate 29, figure 2

Virgulina pontoni Cushman, 1932b, p. 17, pl. 3, fig. 7; Cushman, 1937c, p. 19, pl. 2, figs. 26–28; Renz, 1948, p. 178, pl. 6, fig. 18; Phleger and Parker, 1951, p. 19, pl. 9, figs. 9a–b, 10a–b; Andersen, 1961, p. 92, pl. 20, fig. 3.

Fursenkoina pontoni (Cushman). Akers and Dorman, 1964, p. 35, pl. 8, fig. 32.

Description.—Test free, narrow, elongate, length three times the width, compressed, biserial, ovate in transverse section; chambers inflated, increasing rapidly in size as added; height greater than breadth, early chambers a highly twisted biserial arrangement, making up initial quarter of test, becoming only slightly twisted with three to four pairs of chambers in the latter portion; sutures distinct, depressed, oblique; wall calcareous, hyaline, smooth, finely perforate; aperture a comma-shaped, elongate opening, extending up face of ultimate chamber, with raised margin and distinct toothplate.

Discussion.—*Fursenkoina punctata* (d'Orbigny, 1839a) differs from *F. pontoni* by possessing sutures that are more highly oblique to the periphery.

Distribution.—*Fursenkoina pontoni* was described from the Tertiary of Florida. It is recorded from the Holocene of the Gulf of Mexico, Atlantic, and Caribbean; Pleistocene of the Gulf of Mexico; Pliocene of Italy; Tertiary of Aruba Island; late Miocene to early Pliocene (Gurabo Formation) of the Dominican Republic; Miocene (Gatun Formation) of Panama; late Miocene to early Pliocene (Bowden Formation) of Jamaica; middle to late Miocene (Pozon Formation) of Venezuela; and the early Miocene (St. Croix Formation) of Trinidad. This species is common in the Concepcion and Encanto "biozones".

Family **LOXOSTOMATIDAE**
Loeblich and Tappan, 1962

Genus **LOXOSTOMUM** Ehrenberg, 1854

Loxostomum species A
Plate 29, figure 4

Description.—Test free, small, biserial, tending to become uniserial in the adult, approximately four times as long as broad, first half of test compressed, the later half inflated, ovate in transverse section; chambers distinct, eight to ten pairs in the adult; wall calcareous, hyaline, perforate, ornamented by eight to ten costae, those along the edge extending the entire length of test, several other costae appear in side view only on the latter half of test; aperture terminal, an elongate opening surrounded by a thickened rim in which the costae are connected.

Discussion.—This species is small for the genus and is approximately one-half the size of *L. bradyi* (Asano, 1938).

Distribution.—*Loxostomum* sp. A is rare in the Concepcion and Encanto "biozones".

Loxostomum bradyi (Asano, 1938)
Plate 29, figure 3

Bolivina bradyi Asano, 1938, p. 603, pl. 16, fig. 2.

Loxostoma instabile Cushman and McCulloch, 1942, p. 221, pl. 27, figs. 15–17, pl. 28, figs. 1–7; Cushman and Gray, 1946, p. 36, pl. 6, figs. 7–9.

Bolivina bramletti Kleinpell. Cushman and McCulloch, 1942, p. 189, pl. 22, figs. 7–13 (not Kleinpell, 1938).

Loxostoma bradyi (Asano). Asano, 1950, p. 11, figs. 42, 43.

Loxostomum bradyi (Asano). Uchio, 1960, p. 64, pl. 7, fig. 9.

Bolivina bradyi Asano. Barker, 1960, p. 108, pl. 53, fig. 1.

Bolivina (*Bolivina*) *bradyi* Asano. Smith, 1963, p. 23, pl. 31, figs. 1–2.

Bolivina (*Loxostomum*) *boltovskoyi* Smith, 1963, p. 23, pl. 31, figs. 9–10.

Description.—Test free, biserial, becoming uniserial in adult, approximately four times as long as broad, first half of test compressed, gradually inflated in later half, initial end blunted, gradually increasing in width, broadest near apertural end; usually six to seven pairs of chambers in the adult, inflation of chambers increasing in adult, becoming much higher than broad, last few pairs distinctly elongate, forming a sharp downward-projecting spine at outer margin; a narrow keel on each edge of last chamber; sutures distinct, oblique or gently curved, slightly depressed in adult; wall calcareous, hyaline, smooth, finely perforate; aperture terminal, an elongate opening with a lip and narrow tooth.

Remarks.—This species is variable in the degree of inflation of chambers, the number of spines at outer margin of test, and size of chambers. Cushman and McCulloch (1942) attributed this variation to dimorphism.

Distribution.—*Loxostomum bradyi* was described from the Holocene of the Pacific. It has been recorded from the Recent of the Atlantic, Pleistocene of California, and Pliocene of Japan. It is a rare species in the Encanto "biozone", occurring only at locality PD-68.

Family **CASSIDULINIDAE** d'Orbigny,
in Sagra, 1839

Genus **CASSIDULINA** d'Orbigny, 1826

Cassidulina curvata Phleger and Parker, 1951
Plate 29, figures 5–6

Cassidulina curvata Phleger and Parker, 1951, p. 26, pl. 14, figs. 5a–b; Boltovskoy, 1959, p. 101, pl. 15, fig. 15; Andersen, 1961, p. 113, pl. 25, figs. 3a–c.

Islandiella curvata (Phleger and Parker). Poag, 1981, p. 69, pl. 17, fig. 1, pl. 18, fig. 1.

Description.—Test free, compressed, small, biconvex, chambers biserially arranged and enrolled; periphery acute with thin, well-developed keel; chambers distinct, curved, four to five pairs in last whorl, each set extending into the umbilical region on both sides; sutures distinct, strongly curved, thickened, extending to umbilicus on each side where they converge; wall calcareous, hyaline, smooth, coarsely perforate, optically granular in texture; aperture an elongate slit surrounded by a thin rim, parallel to keel.

Discussion.—*Cassidulina curvata* differs from *C. carapitana* Hedberg, 1937, in possessing a coarsely-perforate rather than finely-perforate wall.

Distribution.—Cassidulina curvata was described from the Holocene of the Gulf of Mexico. It is also recorded from the Holocene of the Atlantic and Caribbean, and Pleistocene of the Gulf of Mexico. It is rare in the Concepcion "biozone" and rare to abundant in the Encanto "biozone".

Cassidulina neocarinata Thalmann, 1950
Plate 30, figure 1

Cassidulina laevigata d'Orbigny var. *carinata* Cushman, 1922b, p. 124, pl. 25, figs. 6–7 (homonym of *C. laevigata* var. *carinata* Silvestri, 1896); Phleger and Parker, 1951, p. 27, pl. 14, figs. 7a–b.

Cassidulina laevigata carinata Cushman. Colom, 1946a, p. 168, pl. 10, fig. 198.

Cassidulina neocarinata Thalmann, 1950 (*nom. nov.*), p. 44; Boltovskoy, 1959, p. 101, pl. 15, fig. 14; Andersen, 1961, p. 113, pl. 25, figs. 4a–c.

Cassidulina carinata Silvestri?. Barker, 1960 (part), p. 110, pl. 54, fig. 2 (not fig. 3).

Description.—Test free, compressed, small, chambers biserially arranged and enrolled, tightly coiled, biconvex; periphery slightly lobulate in side view, acute with a narrow keel; chambers elongate, four pairs of chambers in last whorl, slightly inflated; central umbilical region clear, showing a few chambers of earlier whorls; sutures distinct, slightly depressed; wall calcareous, hyaline, smooth, finely perforate, optically granular in texture; aperture an elongate narrow slit parallel to the periphery along the suture of the last chamber, with a narrow thin rim projecting from the penultimate chamber into the aperture.

Discussion.—Cassidulina neocarinata differs from *C. subcarinata* Uchio, 1960, in not possessing a thin triangular toothplate. *Cassidulina neocarinata* differs from *Cassidulina asanoi* Uchio, 1950, in possessing a clear central umbilical region.

There is confusion in the determination of criteria for the separation of *C. laevigata* d'Orbigny, 1826, and *C. neocarinata* Thalmann, 1950, as discussed by Belford (1966, pp. 138–140). Belford places *C. neocarinata* in synonymy with *C. laevigata* because of the Nørvang (1958) study of the variability of the peripheral keel and aperture of *C. laevigata.* I follow the separation of Phleger and Parker (1951).

Distribution.—Cassidulina neocarinata was described from the Holocene off Florida. It is recorded from the Holocene of the Gulf of Mexico, Caribbean, Atlantic and Pacific; Pleistocene of the Gulf of Mexico; Tertiary of Mallorca and Italy; middle to late Miocene (Cubagua Formation) of Venezuela; and late Miocene to early Pliocene (Bowden Formation) of Jamaica. This species is rare to common in the upper Concepcion "biozone", and rare in the lower Concepcion and Encanto "biozones".

Genus **EHRENBERGINA** Reuss, 1850

Ehrenbergina bosoensis Takayanagi, 1951
Plate 31, figure 1

Ehrenbergina bosoensis Takayanagi, 1951, p. 87, pl. 88, text-figs. 8a–c; Asano, 1952, p. 15, text-figs. 83–84.

Description.—Test free, large, broad as long, biserial, enrolled initially and then uncoiling, compressed perpendicular to the plane of coiling; triangular to subtriangular in transverse section, dorsal side convex, ventral side possessing a median furrow; periphery acute; chambers distinct, five to six pairs in uncoiled portion, increasing fairly rapidly in size as added, overlapping dorsally equal to one-half the width of each chamber; sutures limbate, slightly raised, strongly curved, on dorsal and ventral sides; wall calcareous, hyaline, smooth, finely perforate; aperture an elongate, narrow, curved slit extending from the junction of the ultimate and penultimate chamber to a terminal position.

Discussion.—The specimens from the Mexican Pliocene compare closely to the type figure of Takayanagi (1951), but do not have as well-developed raised sutures.

Distribution.—Ehrenbergina bosoensis was described from the Pliocene of Japan. It is rare in the Encanto "biozone", only occurring at localities SD-4 and PD-35.

Ehrenbergina olmeca, new species
Plate 30, figure 5

Etymology of name.—Named for the Olmecs, a pre-Columbian culture which inhabited the Veracruz–Tabasco region about 2500 years ago.

Description.—Test free, small, slightly broader than long, biserial, enrolled initially and then uncoiling, compressed perpendicular to the plane of coiling; triangular in transverse section, dorsal side convex; periphery carinate and spinose; chambers broader than high, five pairs visible in the uncoiled portion, increasing in size as added, chamber margins overhanging the previous ones on the ventral side; sutures obscured on ventral side, slightly raised on the last pairs of chambers on the dorsal side; wall calcareous, hyaline, finely perforate, ornamented by downward-projecting chamber margins that merge on the ventral side to form a median ridge and extend outward, outer edge forming a distinct spine and serrated periphery; each chamber is further ornamented with a fringe of numerous small spines that project downward from the chamber margins; these spines coalesce on the coiled portion and obscure the early chambers; aperture an elongate slit parallel to the dorsal side in the terminal face of the ultimate chamber.

Diagnosis.—*E. olmeca* is distinguished by overhanging chamber margins with a fringe of small spines on the ventral side and a smooth dorsal surface.

Discussion.—*Ehrenbergina rugosa* Keijzer, 1953, from the Pliocene of the Celebes, Indonesia, differs from *Ehrenbergina olmeca* in possessing raised and ornamented sutures on the dorsal side.

Ehrenbergina pacifica Cushman, 1927f, from the Holocene of the Pacific, differs from *E. olmeca* in lacking the overhanging chamber margins and finely-spinose ornamentation.

Several specimens of *E. olmeca* from locality SD-4 appear to lack spinose ornamentation. Examination of SEM photographs of these specimens revealed the remnants of spines fringing the chambers and ventral ridge. The delicate ornamentation had evidently undergone dissolution.

Types.—Holotype: USNM 400657; paratypes: USNM 400658.

Measurements.—Length: 0.35 mm, width: 0.3–0.4 mm, thickness: 0.2 mm.

Type locality.—Locality PD-70, Potrerillos Dome, south side of Mexican Highway #180, 15.7 km east of Acayucan, State of Veracruz, Mexico. In the Encanto "biozone" (N.19: early Pliocene).

Other localities.—At most localities in the Encanto "biozone" (N.19) (see Text-fig. 15). There are also occurrences at localities ER146 (42–44) of Robinson (1969) from the Bowden Formation (early Pliocene, N.19), Buff Bay, Jamaica.

Ehrenbergina spinea Cushman, 1935
Plate 31, figure 2

Ehrenbergina spinea Cushman, 1935, p. 8, pl. 3, figs. 10–11; Cushman and Todd, 1945, p. 63, pl. 11, fig. 2; Phleger and Parker, 1951, p. 27, pl. 14, fig. 18; Drooger, 1953, p. 141, pl. 22, figs. 11a–c; Drooger and Kaasschieter, 1958, p. 43, pl. 2, fig. 7; Boltovskoy, 1959, p. 101, pl. 16, figs. 1a–b.

Description.—Test free, small, slightly broader than long, biserial, enrolled initially and then uncoiling; biconvex in transverse section; periphery carinate, with each side extended into a spine; distal end and base broadly rounded; chambers inflated, increasing rapidly in size as added, broader than high, three pairs of chambers visible on dorsal side; sutures distinct in uncoiled portion and slightly depressed, obscured in early coiled portion; wall smooth, calcareous, hyaline, finely perforate; aperture narrow, an elongate slit in face of ultimate chamber.

Discussion.—*Ehrenbergina amina* Bermudez, 1949, from the Gurabo Formation of the Dominican Republic (early Miocene to late Pliocene), differs from *E. spinea* in its shorter lateral spines and higher apertural face.

Distribution.—*Ehrenbergina spinea* was described from the Holocene of the Gulf of Mexico. It is recorded from the Holocene of the Atlantic and Caribbean, Tertiary of Aruba, late Miocene to early Pliocene (Bowden Formation) of Jamaica, and middle to late Miocene (Cubagua Formation) of Venezuela. It is rare in the lower Concepcion "biozone" at locality PD-43 and in the Encanto "biozone" at locality PD-58.

Ehrenbergina undulata Parker, 1953
Plate 31, figure 3

Ehrenbergina trigona Goes. Cushman, 1922b, p. 135, pl. 26, fig. 4; Cushman, 1927f, p. 6, pl. 2, fig. 3; Cushman, 1936c, p. 425, pl. 3, figs. 9a–b (not Goes, 1896).

Ehrenbergina undulata Parker, *in* Phleger, Parker, and Pierson, 1953, p. 46, pl. 10, figs. 14–16; Gianelli, Menesini, Salvatorini, and Tavani, 1968, pl. 2, figs. 1a–b; Nishimura, Konda, Matsuoka, Nishida, and Ohno, 1977, pl. 4, figs. 1, 2.

Description.—Test free, small, as broad as long, biserial, enrolled initially and then uncoiling, compressed perpendicular to the plane of coiling; triangular to subtriangular in transverse section, dorsal side slightly convex, ventral side with a furrow or single keel formed by the merging of the carinate margins of the chambers; periphery acute with a spine at the end of each chamber; chambers slightly inflated in later portion of test, five to six pairs of chambers in the uncoiled portion, increasing gradually in size as added; sutures limbate, flush with surface in early portion, later slightly depressed; wall calcareous, hyaline, smooth except for small spines on initial portion of test and along the median ridge, finely perforate; aperture an elongate slit parallel to dorsal side, extending from junction of ultimate and penultimate chambers to a terminal position in the ultimate chamber, with a thin lip.

Discussion.—The Mexican specimens appear to be as compressed as those in the original description of Parker (*in* Phleger, Parker, and Pierson, 1953), although the extent of the compression cannot be satisfactorily determined from the type figure because there are no edge or apertural views.

Distribution.—*Ehrenbergina undulata* was described from a Pleistocene core in the North Atlantic Ocean. It is also recorded from a Pliocene core in the Philippine Sea; and the Pliocene of Italy. It is rare in the Concepcion and Encanto "biozones".

Genus **GLOBOCASSIDULINA** Voloshinova, 1960

Globocassidulina subglobosa (Brady, 1881)
Plate 30, figures 3–4

Cassidulina subglobosa Brady, 1881, p. 60; Brady, 1884, p. 430, pl. 54, figs. 17a–c; Galloway and Heminway, 1941, p. 425, pl. 32, figs. 2a–b; Cushman and Todd, 1945, p. 61, pl. 10, figs. 8a–b; Renz, 1948, p. 125, pl. 9, figs. 11, 12; Phleger and Parker, 1951, p. 27, pl. 14, figs. 11, 12.

Islandiella subglobosa (Brady). Akers and Dorman, 1964, p. 39, pl. 11, fig. 19.

Globocassidulina subglobosa (Brady). Belford, 1966, p. 149, pl. 25, figs. 11–16; LeRoy and Levinson, 1974, p. 14, pl. 7, fig. 8.

Globocassidulina oriangulata Belford, 1966, p. 148, pl. 25, figs. 1–5.

Description.—Test free, subglobular in side view, coiled biserial, peripheral margin rounded, ovate in transverse section, chambers biserially arranged and enrolled; chambers inflated, four to five pairs in last whorl, increasing gradually in size as added; sutures narrow, distinct, smooth, slightly curved; wall calcareous, hyaline, smooth, finely perforate, optically granular in texture; aperture narrow, in depression of the apertural face, varying in shape from a straight, narrow slit to a chevron-shaped opening, with a lip attached to outer margin varying from triangular to straight, toothplate formed by infolding of apertural face, free edge forming an elongate tooth.

Discussion.—There is a wide variation in shape of the aperture in specimens from the present study area. The aperture varies from a straight slit to an "L"-shaped opening with the lower portion following the suture of the ultimate and penultimate chambers (see Pl. 30, figs. 3a, d). This variation could be a result of dimorphism or related to growth stages of *Globocassidulina subglobosa.*

Belford (1966, p. 148) placed forms with a "trifid" aperture in a new species, *G. oriangulata.* This species is placed in synonymy with *G. subglobosa,* herein. Additional studies of *G. subglobosa* from large populations could define the intraspecific variation of the aperture in this species.

Distribution.—*Globocassidulina subglobosa* was described from the Holocene of the Atlantic. It is a widely-distributed species, recorded from the Holocene of the Pacific, Gulf of Mexico, Caribbean, and Mediterranean; Pleistocene of the Gulf of Mexico; Pliocene of Japan; Tertiary of Aruba, Colombia, Cuba, Italy, Papua New Guinea, and Siberoet Islands of the East Indies; late Miocene to early Pliocene (Bowden Formation) of Jamaica; Oligo-Miocene (Sombrerito Formation) of the Dominican Republic; and early Miocene (Ponce Formation) of Puerto Rico. It is rare to common in the Concepcion and Encanto "biozones".

Genus **LERNELLA** Saidova, 1975

Lernella inflata (LeRoy, 1944)
Plate 30, figure 2

Cassidulina inflata LeRoy, 1944a, p. 37, pl. 4, figs. 30–31; LeRoy, 1964, p. 40, pl. 11, figs. 13, 14.

Cassidulinoides inflatus (LeRoy). Belford, 1966, p. 54, pl. 26, figs. 14–17.

Lernella auri Saidova, 1975, p. 328, pl. 114, fig. 2.

Lernella inflata (LeRoy). Nomura, 1983, p. 86, pl. 2, figs. 9a–c, pl. 24, figs. 4, 5.

Description.—Test free, small, height about one-and-one-half times the thickness, compressed, chambers biserially arranged and enrolled, tightly coiled; periphery distinctly lobate, margin rounded; chambers inflated, four to five pairs in final whorl, increasing rapidly in size; height and width of chambers about equal; sutures distinct, incised; wall calcareous, hyaline, smooth, finely perforate, optically granular in texture; aperture a narrow curved slit along the outer margin of a broad imperforate flap that is attached to the penultimate chamber.

Discussion.—*Lernella inflata* is distinguished by the incised sutures and the large triangular imperforate flap projecting into the apertural face (see Pl. 30, fig. 2a).

Belford (1966, p. 54) states that the wall of this species is granular in texture. It therefore cannot be classified as *Cassidulinoides* Cushman, 1927a, which, according to Loeblich and Tappan (1964a, p. C556), has a radiate wall.

Distribution.—*Lernella inflata* was described from the Miocene of the east coast of central Sumatra. It is recorded from the Neogene of Papua New Guinea; Neogene (Shimajiri Formation) of Okinawa; Miocene (Telisa and lower Palembang formations) of Sumatra. It is rare in the Concepcion and Encanto "biozones" of the study area.

Lernella seranensis (Germeraad, 1946)
Plate 18, figure 4

Cassidulinoides seranensis Germeraad, 1946, p. 72, pl. 5, figs. 5–6; Belford, 1966, p. 55, pl. 26, figs. 18–21.

Description.—Test free, elongate, early stage subglobular, involute with chambers biserially arranged and enrolled, later portion uncoiled, length twice the width, circular in transverse section; chambers inflated, slightly overlapping previous ones, five pairs of chambers in last coil, last pair making up about two-thirds of entire test; sutures slightly depressed, distinct; periphery rounded in adult, subacute in early stage; wall calcareous, hyaline, smooth, finely perforate, optically granular in texture; aperture with a large imperforate plate projecting from the penultimate chamber into a depression in the ultimate chamber, forming a curved, narrow slit following the suture, two-thirds the length of the last chamber.

Remarks.—*Lernella marksi* (Drooger, 1953), differs from *L. seranensis* in that the chambers are more strongly overlapping and that there are fewer chambers in the last coil.

Distribution.—*Lernella seranensis* was described from the Neogene of the Island of Ceram, Indonesia. This species is rare in the Concepcion and Encanto "biozones".

Genus **RUTHERFORDOIDES** McCulloch, 1981

Rutherfordoides erecta (Cushman and Renz, 1941)

Plate 18, figure 2

Cassidulinoides erecta Cushman and Renz, 1941, p. 25, pl. 4, figs. 6–7; Renz, 1948, p. 126, pl. 9, figs. 15a–c.

Description.—Test free, small, elongate, early stage involute with chambers biserially arranged and enrolled, later portion uncoiled; length two-and-one-half times the width, circular in transverse section; chambers inflated, three to four pairs in uncoiled portion, increasing rapidly in size, last pair making up one-half the test; sutures distinct, depressed; wall smooth, calcareous, hyaline, finely perforate, optically granular in texture; aperture an elongate narrow opening, beginning at suture line of ultimate chamber and extending along inner margin to a terminal position, surrounded by a serrated lip.

Discussion.—*Rutherfordoides tenuis* (Phleger and Parker, 1951) differs from *R. erecta* in the much less inflated chambers and greater compression in ventral view.

Hastilina Nomura, 1983, was erected to separate biserial, loosely-coiled taxa with an optically-granular wall texture, from *Fursenkoina* Loeblich and Tappan, 1961, which has a twisted biserial arrangement and no early coiled portion. *Virgulina mexicana* Cushman, 1922b, was designated by Nomura as the type species of *Hastilina.*

However, McCulloch (1977) erected the genus *Rutherfordia* with *R. rotundiformis* as the type. The type species, *R. rotundiformis,* is identical to *Virgulina mexicana* Cushman and is considered herein to be a junior synonym. McCulloch did not discuss wall texture, yet the specimen from off Japan figured by her is similar to specimens figured by Nomura (1983).

McCulloch (1981, p. 6, item 4) published a new name, *Rutherfordoides,* to replace the name *Rutherfordia* McCulloch, 1977, which was preoccupied. It is considered herein that *Hastilina* Nomura, 1983 is a junior synonym of *Rutherfordoides* McCulloch, 1981.

Distribution.—*Rutherfordoides erecta* was described from a well in the state of Falcon, Venezuela and is also recorded there from the early Miocene (San Lorenzo Formation). It is rare in the lower Concepcion "biozone".

Rutherfordoides mexicana (Cushman, 1922)

Plate 18, figure 3

Virgulina mexicana Cushman, 1922b, p. 120, pl. 23, fig. 8; Cushman, 1937c, p. 29, pl. 5, fig. 4; Phleger and Parker, 1951, p. 19, pl. 9, figs. 6, 7, 8; Phleger, Parker, and Pierson, 1953, p. 34, pl. 7, figs. 6–7; Asano, 1958, p. 14, pl. 4, figs. 1–2; Andersen, 1961, p. 91, pl. 20, fig. 4.

Cassidulinoides bifrons Drooger, 1953, p. 140, pl. 24, figs. 14–15.

Virgulina rotundata Parr. Uchio, 1960, pl. 6, figs. 15–16 (not *Virgulina rotundata* Parr, 1950).

Virgulina bradyi Cushman. Matsunaga, 1963, pl. 41, figs. 12a–b (not *V. bradyi* Cushman, 1922b).

Hastilina mexicana (Cushman). Nomura, 1983, p. 82, pl. 2, figs. 7a–c, pl. 3, fig. 4.

Rutherfordia rotundiformis McCulloch, 1977 (part), p. 249, pl. 105, figs. 6–7 (not figs. 8–10).

Description.—Test free, elongate, length two-and-one-half times the width, early portion of test indistinct, later portion biserially arranged and uncoiled, circular in transverse section; chambers distinct, inflated, slightly overlapping previous chambers, four to five pairs of chambers visible on dorsal side, last pair of chambers making up almost two-thirds of the test in ventral view; sutures slightly depressed, narrow; wall calcareous, hyaline, smooth, finely perforate, optically granular in texture; aperture an elongate opening in a depression of the apertural face, extending from inner margin of ultimate chamber to subterminal position.

Distribution.—*Rutherfordoides mexicana* was described from the Holocene of the Gulf of Mexico. It is recorded as *Virgulina mexicana* from the Holocene of the Pacific, Pleistocene of the Gulf of Mexico and Aruba Island, and the Miocene (Onnagawa Formation) of Japan. It is rare in the Encanto "biozone", occurring only at localities PD-70 and 72.

Rutherfordoides tenuis (Phleger and Parker, 1951)

Plate 18, figure 5

Cassidulinoides tenuis Phleger and Parker, 1951, p. 27, pl. 14, figs. 14–17; Parker, 1958, p. 272, pl. 4, figs. 18, 19; Matsunaga, 1963, pl. 49, figs. 6a–b.

Description.—Test free, small, slender, circular to ovate in cross-section, early portion coiled, chambers biserially enrolled, later portion uncoiling; chambers distinct, four to five pairs, somewhat inflated, increasing gradually in size; sutures narrow, depressed; wall calcareous, hyaline, smooth, finely perforate, optically granular in texture; aperture a broad loop in a depression, extending from base of ultimate chamber, along suture line to a point near apex of test, with a toothed margin.

Discussion.—Rutherfordoides tenuis differs from *R. bradyi* (Norman, 1880) in its rounded cross-section and more elongate shape.

Distribution.—Rutherfordoides tenuis was described from the Pleistocene of the Gulf of Mexico. It is recorded as *Cassidulinoides tenuis* from the Holocene of the Gulf of Mexico, Mediterranean; and Neogene of Japan. It is rare in the Concepcion and Encanto "biozones".

Superfamily **NONIONACEA** Schultze, 1854

Family **NONIONIDAE** Schultze, 1854

Subfamily **CHILOSTOMELLINAE** Brady, 1881

Genus **ALLOMORPHINA** Reuss, *in* Czjzek, 1849

Allomorphina macrostoma Karrer, 1862

Plate 31, figures 6–7

Allomorphina macrostoma Karrer, 1862, p. 448, pl. 2, figs. 4a–d; Cushman and Todd, 1945, p. 64, pl. 11, fig. 3; Cushman and Todd, 1949b, p. 68, pl. 12, figs. 4–5; Todd and Low, 1976, p. 20, pl. 4, fig. 8.

Description.—Test free, trochospiral, involute, ovate in side view, periphery broadly rounded, circular in transverse section; chambers fairly distinct, strongly embracing, three visible in the last whorl, ultimate chamber comprising five-sixths of the test in ventral view, the penultimate and antepenultimate chambers barely visible in ventral view; sutures indistinct, flush with surface, with a series of regularly-spaced vertical pores following the suture line along the contact of the three chambers; wall smooth, calcareous, finely perforate; aperture a moderately-arched, elongate slit parallel to the suture between the ultimate and penultimate chambers, bordered by a distinct lip.

Discussion.—Allomorphina trigona Reuss, 1850, differs from *A. macrostoma* in its more projecting early chambers and triangular outline.

Distribution.—Allomorphina macrostoma was described from the Tertiary of Germany. It is recorded from the Tertiary of Puerto Rico and Czechoslovakia; Miocene of the Vienna Basin; and the late Miocene to early Pliocene (Bowden Formation) of Jamaica. This species is rare in the Encanto "biozone".

Genus **CHILOSTOMELLA** Reuss, *in* Czjzek, 1849

Chilostomella czizeki Reuss, 1850

Plate 31, figures 4–5

Chilostomella czizeki Reuss, 1850, p. 380, pl. 48, figs. 13a–d; Cushman, 1926e, p. 74, pl. 11, fig. 2; Galloway and Heminway, 1941, p. 409, pl. 28, figs. 3a–c; Coryell and Mossman, 1942, p. 237, pl. 36, figs. 24–25; Bermudez, 1949, p. 274, pl. 21, figs. 16–21; Cushman and Todd, 1949c, p. 90, pl. 15, figs. 20–22.

Chilostomella ovoidea Reuss. Renz, 1948, p. 126, pl. 9, figs. 16a–b (not Reuss, 1850).

Description.—Test free, inflated, planispiral and involute, fusiform in side view, circular in transverse section, dorsal side slightly protruding, length one-and-one-half times the breadth, greatest width near middle of test; chambers two to a whorl, strongly embracing, ultimate chamber covering almost two-thirds of the penultimate chamber, line of contact on the dorsal side deeply concave exposing several of the early chambers; sutures narrow, flush with surface, indistinct; wall calcareous, hyaline, smooth, thin, finely perforate; aperture a narrow interiomarginal equatorial crescent comprising about one-fourth the circumference of the test.

Discussion.—Chilostomella ovidea Reuss, 1850, differs from *C. czizeki* in that the chambers of the ultimate whorl are not visible externally.

Chilostomella oolina Schwager, 1878, differs from *C. czizeki* in its more cylindrical shape and greater exposure of the penultimate chamber on the dorsal side.

Distribution.—Chilostomella czizeki was described from the Tertiary of Germany. It is recorded from the early Miocene (Ponce Formation) of Puerto Rico, Charco Azul Formation of Panama, middle Oligocene to early Miocene (Sombrerito Formation) of the Dominican Republic, and the late Miocene to early Pliocene (Bowden Formation) of Jamaica. This species is rare in the Concepcion and Encanto "biozones" of the study area.

Genus **QUADRIMORPHINA** Finlay, 1939

Quadrimorphina glabra (Cushman, 1927)

Plate 31, figure 8

Valvulineria vilardeboana (d'Orbigny) var. *glabra* Cushman, 1927d, p. 161, pl. 4, figs. 5–6.

Valvulineria laevigata Phleger and Parker, 1951, p. 25, pl. 13, figs. 11–12.

Valvulineria glabra Cushman. Uchio, 1960, pl. 8, figs. 6–7.

Rotamorphina glabra (Cushman). Andersen, 1961, p. 104, pl. 23, figs. 2a–c.

Quadrimorphina vilardeboana glabrà (Cushman). Akers and Dorman, 1964, p. 50, pl. 11, figs. 28–29.

Quadrimorphina laevigata (Phleger and Parker). Belford, 1966, p. 155, pl. 37, figs. 21–25.

Description.—Test free, small, trochospiral, biconvex, circular in outline and slightly lobate, periphery rounded; chambers distinct, inflated, five in the last whorl, gradually increasing in size as added, all visible on spiral side, ultimate chamber with a lobelike plate extending into and covering the umbilical area; wall calcareous, hyaline, smooth, finely perforate; aperture interiomarginal, umbilical-extraumbilical, and partially covered by a projecting umbilical flap.

Discussion.—Quadrimorphina glabra (Cushman, 1927d) is a distinct species and separate from *Rosalina vilardeboana* d'Orbigny, 1839b. Barker (1960, p. 178), in agreement with d'Orbigny (1839b), assigned the species *vilardeboana* to the genus *Rosalina*.

Quadrimorphina Finlay, 1939, was originally defined with four chambers to a whorl. Belford (1966, p. 155), however, stated that assignment of four chambers to the last whorl was an arbitrary one since *Quadrimorphina laevigata* (Phleger and Parker, 1951) has four to six chambers in the last whorl. *Valvulineria iijimai* Ujiie, 1959, from the Miocene of Japan, appears similar and may be conspecific.

Discussion.—*Quadrimorphina glabra* was described from the Holocene of the Pacific Ocean. It is recorded from the Holocene and Pleistocene of the Gulf of Mexico, and Neogene of Papua New Guinea. This species is rare in the Concepcion and Encanto "biozones".

Subfamily **NONIONINAE** Schultze, 1854

Genus **ASTRONONION**
Cushman and Edwards, 1937

Astrononion gallowayi Loeblich and Tappan, 1953
Plate 32, figure 1

Astrononion stellatum Cushman and Edwards, 1937, p. 32, pl. 3, figs. 9–11 [homonym of *Astrononion stellatum* (Terquem, 1882)]; Cushman and Todd, 1947, p. 13, pl. 2, fig. 15.

Astrononion gallowayi Loeblich and Tappan, 1953 (*nom. nov.*), p. 90, pl. 17, figs. 4–7; Feyling-Hanssen, 1964, p. 332, pl. 18, fig. 4; Feyling-Hanssen, Jorgensen, Knudsen, and Andersen, 1971, p. 266, pl. 10, figs. 10–12; Hansen and Lykke-Andersen, 1976, p. 24, pl. 22, figs. 5–9.

Astrononion stellatum Cushman and Edwards. Schnitker, 1971, p. 193, pl. 20, figs. 7a–b.

Description.—Test free, planispiral and involute, compressed, umbilical area concave, periphery rounded; chambers distinct, nine to ten in final whorl, increasing gradually in size, strongly inflated, each with backward-projecting umbilical flap partially covering the preceding suture and umbilical region, leaving a small, chamberlike cavity beneath it; sutures gently curved, depressed; wall calcareous, hyaline, smooth, finely perforate except for the umbilical flaps; primary aperture a low interiomarginal, equatorial slit extending from one umbilicus to the other; supplemental openings at the outer posterior margin of the umbilical flaps along their sutural extension.

Discussion.—*Astrononion gallowayi* differs from *A. stelligerum* (d'Orbigny, 1839c), in the more inflated test and broader umbilical flaps along the sutures.

Astrononion hamadaense Asano, 1950, from the Pliocene of Japan, is similar to *A. gallowayi* but has less elongate umbilical extensions along the sutures.

Distribution.—*Astrononion gallowayi* was described from the Holocene of the North Atlantic. It is recorded from the Holocene of the Pacific, and Pleistocene of Norway. It is rare, occurring in the study area only at locality SD-12, in the Encanto "biozone".

Genus **FLORILUS** Montfort, 1808

Florilus atlanticus (Cushman, 1947)
Plate 32, figure 2

Nonionella atlantica Cushman, 1947b, p. 90, pl. 20, figs. 4–5; Phleger and Parker, 1951 (part), p. 11, pl. 5, figs. 21a–b, 22a–b (not figs. 23a–b); Phleger, Parker, and Pierson, 1953, p. 31, pl. 6, figs. 9–10; Parker, 1954, p. 507, pl. 6, figs. 6, 7; Todd and Brönnimann, 1957, p. 32, pl. 5, figs. 30–31; Hansen and Lykke-Andersen, 1976, p. 23, pl. 21, figs. 9–12.

Pseudononion atlantica (Cushman). Andersen, 1961, p. 84, pl. 18, figs. 1a–b, 2a–c.

Florilus atlanticus (Cushman). Akers and Dorman, 1964, p. 34, pl. 6, figs. 26, 27.

Description.—Test free, compressed, asymmetrical, dorsal side showing earlier coils, which are covered on the ventral side; periphery rounded; umbilical region on ventral side slightly depressed, filled with granular skeletal material, which extends along sutures on ventral and dorsal side; chambers distinct, inflated, nine to 11 in the final whorl, increasing rapidly in size as added; sutures curved, depressed and incised near umbilical area, filled with granular skeletal material; wall calcareous, hyaline, finely perforate, smooth except for areas near the sutures, umbilicus and base of apertural face, which are papillate; aperture obscured by skeletal deposits, but is probably an interiomarginal equatorial opening.

Discussion.—The genus *Pseudononion* Asano, 1936a, was erected to include forms that were bilaterally asymmetrical but did not have the final chamber overhanging the umbilical region as does *Nonionella* Cushman, 1926c. Loeblich and Tappan (1964a, p. C746) placed *Pseudononion* in synonymy with *Florilus* Montfort, 1808, and included those asymmetrical involute forms with a flaring test and no umbilical chamber extension. Hansen and Lykke-Andersen (1976) made *Florilus* a synonym of *Nonion* Montfort, 1808, based on wall structure. They considered *Nonionella* a valid genus and placed all the asymmetrical involute forms in that genus. Because of the wide difference between those forms that are asymmetical-involute (included in *Florilus* of Loeblich and Tappan) and others that are trochospiral throughout with final chamber overhanging the umbilical region (*Nonionella* of Loeblich and Tappan), *Florilus* in the sense of Loeblich and Tappan, 1964a, is used in this study to separate the two forms.

Florilus basispinata (Cushman and Moyer, 1930) differs from *F. atlanticus* in being more compressed and having less granular skeletal material developed in the umbilical areas and along the sutures.

Distribution.—*Florilus atlanticus* was described from the Holocene of the Atlantic. It is also recorded from the Holocene of the Gulf of Mexico and Caribbean;

Pleistocene of the Gulf Coast. This species is common in the upper Concepcion "biozone" at locality SD-29.

Florilus grateloupi (d'Orbigny, 1839)
Plate 32, figure 3

Nonionina grateloupii d'Orbigny, *in* Sagra, 1839, pl. 6, figs. 6–7 (plates published separately).
Nonion grateloupi (d'Orbigny). Cushman, 1939, p. 21, pl. 6, figs. 1–7; Asano, 1950, p. 2, text-figs. 3–4; Phleger and Parker, 1951, p. 11, pl. 5, fig. 18; Todd and Brönnimann, 1957 (part), p. 32, pl. 5, figs. 27a–b (not figs. 28a–b); Schnitker, 1971, p. 206, pl. 10, figs. 6a–b.
Pseudononion grateloupi (d'Orbigny). Andersen, 1961, p. 84, pl. 18, figs. 3a–c.
Florilus grateloupi (d'Orbigny). Akers and Dorman, 1964, p. 34, pl. 6, fig. 36.

Description.—Test free, compressed, asymmetrical in edge view, twice as high as broad in side view, dorsal side evolute, ventral side involute; periphery rounded; umbilical region slightly depressed, filled with granular skeletal material extending along sutures on dorsal and ventral side; chambers inflated, 12 in the last whorl, increasing rapidly in height as added; ultimate chamber twice as high as broad in edge view with nearly parallel sides; sutures distinct, depressed, slightly curved, covered with granular material near the umbilical area; wall calcareous, hyaline, finely perforate, smooth except for granular skeletal material near the sutures, umbilicus and base of apertural face; aperture obscured by granular material but probably an interiomarginal equatorial opening.

Discussion.—Florilus subgrateloupi (Galloway and Heminway, 1941), from the San Sebastian Formation of Puerto Rico, differs from *F. grateloupi* in its much thicker test, and smaller height-to-width ratio.

Distribution.—Florilus grateloupi was described from the Holocene of the Caribbean Sea. It is recorded from the Holocene of the Atlantic and Gulf of Mexico, Pleistocene of the Gulf Coast, and Pliocene of Japan. It is common in the upper Concepcion "biozone" at locality SD-29.

Genus **NONIONELLA** Cushman, 1926c

Nonionella basiloba
Cushman and McCulloch, 1940
Plate 32, figure 4

Nonionella basiloba Cushman and McCulloch, 1940, p. 162, pl. 18, figs. 3a–b; Andersen, 1961, p. 85, pl. 18, figs. 5a–c; Akers and Dorman, 1964, p. 46, pl. 6, figs. 14–15.
Nonionella opima Cushman, 1947b, p. 90, pl. 20, figs. 1–3.
Nonionella turgida (Williamson). Todd and Brönnimann, 1957, p. 32, pl. 6, figs. 3–4 (not *Rotalina turgida* Williamson, 1858).

Description.—Test free, small, trochospiral, spiral side flattened and evolute, ventral side highly convex, periphery rounded; chambers inflated, nine to ten in the final whorl, increasing in size rapidly as added, ventral side with a highly-inflated ultimate chamber forming more than one-half the surface of the test, overhanging the umbilical area; sutures distinct, slightly curved, slightly depressed on the spiral side and near the umbilicus on the ventral side; wall calcareous, hyaline, smooth, perforate; aperture an interiomarginal opening, umbilical-extraumbilical, extending under the lobe of the ultimate chamber.

Discussion.—Nonionella turgida (Williamson, 1858) differs from *N. basiloba* in its more highly-compressed test, more chambers in the final whorl, and a less inflated final chamber.

Distribution.—Nonionella basiloba was described from the Holocene of the Pacific Ocean. It is also recorded from the Holocene of the Atlantic, Caribbean, and Gulf of Mexico; Pleistocene of the Gulf of Mexico; and Neogene of Aruba. It is rare in the Concepcion and Encanto "biozones".

Genus **PULLENIA** Parker and Jones,
in Carpenter, Parker, and Jones, 1862

Pullenia bulloides (d'Orbigny, 1846)
Plate 32, figure 5

Nonionina bulloides d'Orbigny, 1826 (*nom. nud.*), p. 293.
Nonionina bulloides d'Orbigny, 1846, p. 107, pl. 5, figs. 9, 10.
Pullenia bulloides (d'Orbigny). Galloway and Morrey, 1929, p. 43, pl. 6, fig. 16; Galloway and Heminway, 1941, p. 360, pl. 15, fig. 4; LeRoy, 1964, p. 41, pl. 10, figs. 30–31.

Description.—Test free, planispiral, involute, spheroidal, circular in side view, ovate in apertural view; chambers distinct, inflated, four to five in the final whorl increasing gradually in size; sutures distinct, radial, slightly depressed between last few chambers; wall calcareous, hyaline, very finely perforate; aperture a narrow crescentic interiomarginal slit, extending from one umbilicus to the other, with a thin lip.

Discussion.—The genus *Pullenia* Parker and Jones, 1862, type species *Pullenia sphaeroides* (d'Orbigny, 1826) had no type description, type level or type locality and is considered by Loeblich and Tappan (1964a, p. C748) a *nomen nudum.* Since *Pullenia bulloides* (d'Orbigny, 1846) is a valid species, Loeblich and Tappan (1964a, p. C748) designated it as type species for *Pullenia* Parker and Jones, 1862, by monotypy (only valid species originally included).

Nonionina bulloides d'Orbigny, 1826, is also a *nomen nudum* since it lacked a type figure or description. D'Orbigny (1846) later described and figured the species thus validating the name.

Cushman and Todd (1943, p. 15), in their work on the genus *Pullenia* and its species, stated, "The characters and other data are so obscure that it seems best to allow the name *sphaeroides* as applied to *Pullenia* to lapse". Many of the forms assigned to *P. sphaeroides* by various authors are probably *P. bulloides.*

Pullenia subsphaerica Parr, 1950, is a slightly compressed form that may be conspecific with *P. bulloides.*

Distribution.—*Pullenia bulloides* was described from the Tertiary of the Vienna Basin. It is recorded from the Holocene of the Atlantic, Pacific, and Gulf of Mexico; Pleistocene of the Gulf of Mexico; Tertiary of Italy and Ecuador; late Miocene to early Pliocene (Bowden Formation) of Jamaica; early Miocene (Ponce Formation) of Puerto Rico; middle Pliocene (Mao Formation) of the Dominican Republic; Oligo-Miocene (Cipero Formation) of Trinidad; and the Neogene (Shimajiri Formation) of Okinawa. This species is rare in the lower Concepcion "biozone" at locality PD-43 and rare to common in the Encanto "biozone".

Pullenia quinqueloba (Reuss, 1851)
Plate 32, figure 6

Nonionina quinqueloba Reuss, 1851, p. 71, pl. 5, figs. 31a–b.
Pullenia compressa Seguenza, 1880, p. 307, pl. 17, fig. 14.
Pullenia quinqueloba Reuss. Cushman and Todd, 1943, p. 10, pl. 2, fig. 5, pl. 3, fig. 8; Marks, 1951, p. 69, pl. 7, figs. 19a–b; Agip Mineraria, 1957, pl. 44, fig. 10; Becker and Dusenbury, 1958, p. 27, pl. 6, figs. 3a–b; Dieci, 1959, p. 87, pl. 7, figs. 7a–b; Schnitker, 1971, p. 206, pl. 10, figs. 11a–b.

Description.—Test free, planispiral, involute, compressed, periphery rounded to subrounded, slightly lobate; chambers distinct, inflated, five in the last whorl, gradually increasing in size as added; sutures distinct, slightly depressed, slightly curved, nearly radial; wall calcareous, hyaline, smooth, finely perforate; aperture a narrow crescentic interiomarginal opening extending to the umbilicus on either side, with a distinct lip.

Discussion.—*Pullenia subcarinata* (d'Orbigny, 1839b) differs from *P. quinqueloba* in possessing six chambers in the last whorl and a more inflated test.

Distribution.—*Pullenia quinqueloba* was described from the Tertiary of Germany. It is recorded from the Holocene of the Pacific, Atlantic, Gulf of Mexico, and Caribbean; Pleistocene of the Gulf Coast, and Caribbean; Tertiary of Italy, Colombia, Fiji and Europe. This species is rare in the Encanto "biozone".

Pullenia salisburyi Stewart and Stewart, 1930
Plate 32, figure 7

Pullenia salisburyi Stewart and Stewart, 1930, p. 72, pl. 8, figs. 2a–b; Cushman and Todd, 1943, p. 20, pl. 3, figs. 10–11; Cushman and Gray, 1946, p. 43, pl. 8, figs. 2–4; Renz, 1948, p. 155, pl. 12, figs. 24a–b; Asano, 1951, p. 11, text-figs. 11, 12; Leroy, 1964, p. 41, pl. 3, figs. 10a–b; Todd and Low, 1976, p. 38, pl. 5, fig. 20.

Description.—Test free, planispiral, involute, compressed; periphery subacute in edge view, slightly lobate in side view; chambers slightly inflated, distinct, usually six in the final whorl, gradually increasing in size as added; sutures slightly depressed, radial and slightly curved; wall smooth, finely perforate; aperture a narrow crescentic interiomarginal slit with a narrow lip, extending from the umbilicus of one side to the opposite side.

Discussion.—This species differs from *P. quinqueloba* (Reuss, 1851) in possessing six chambers instead of five in the final whorl and in its greater compression.

Distribution.—*Pullenia salisburyi* was described from the early Pliocene of California. It is recorded from the Holocene of the Pacific; Neogene of Italy, Japan and Okinawa; early Miocene (San Lorenzo Formation) of Venezuela. Holocene occurrences of the species appear to be restricted to the Pacific province. Only early Pliocene or Miocene occurrences are reported from the Atlantic, Mediterranean and Caribbean areas. *Pullenia salisburyi* occurs only at locality PD-68 in the Encanto "biozone" of the study area and may be reworked from older sediments.

Family **ALABAMINIDAE** Hofker, 1951

Genus **GYROIDINA** d'Orbigny, 1826

Gyroidina orbicularis d'Orbigny, 1826
Plate 33, figure 1–2

Gyroidina orbicularis d'Orbigny, 1826, p. 278, Modeles no. 13*; Cushman, 1931, p. 37, pl. 8, figs. 1–2; Phleger and Parker, 1951, p. 22, pl. 11, figs. 11–12; Parker, 1954, p. 528, pl. 9, figs. 13–18; Akers and Dorman, 1964, p. 36, pl. 10, figs. 31–32; Belford, 1966, p. 164, pl. 27, figs. 7–14; LeRoy and Levinson, 1974, p. 14, pl. 7, figs. 14–16.

Description.—Test free, trochoid, unequally biconvex, spiral side slightly convex, umbilical side strongly convex with slight depression, circular in outline, periphery subacute; chambers distinct, eight to 12 in the last whorl, all visible on spiral side; sutures flush with surface, radial on spiral and umbilical sides; wall smooth, calcareous, hyaline, finely perforate; aperture an interiomarginal slit in the apertural face midway between the periphery and umbilicus, with a narrow lip.

Discussion.—*Gyroidina longispina* Tedeschi and Zanmatti, 1957, from the late Pliocene of Italy, is similar to *G. orbicularis* and may be a junior synonym.

Distribution.—*Gyroidina orbicularis* was described from the Holocene of the Adriatic Sea. It is recorded from the Holocene of the Atlantic, Pacific, and Gulf of Mexico; Neogene of Papua New Guinea. It is rare in the Encanto "biozone".

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* "Modeles no. 13" was a plaster cast model used by d'Orbigny to depict this species.

Gyroidina? **regularis** (Phleger and Parker, 1951)
Plate 34, figures 4–5

Eponides regularis Phleger and Parker, 1951, pt. 2, p. 21, pl. 11, figs. 3a–b, 4a–c; Parker, 1954, p. 529, pl. 9, figs. 16, 17; Poag, 1981, p. 64, pl. 1, fig. 3, pl. 2, fig. 3.

Gyroidina venezuelana (Renz) var. *arubana* Drooger, 1953, p. 138, pl. 22, figs. 5–6.

Neoeponides regularis (Phleger and Parker). Andersen, 1961, p. 103, pl. 23, figs. 3a–b.

Gyroidinoides regularis (Phleger and Parker). Akers and Dorman, 1964, p. 37, pl. 10, figs. 7–8.

Description.—Test free, small, trochospiral, biconvex, circular in outline, periphery subacute, umbilical side with deep umbilicus; chambers distinct, eight to nine in the last whorl, all visible on the spiral side, gradually increasing in size as added; distinct, flush with surface, radial on both the spiral and umbilical sides; wall calcareous, hyaline, smooth, finely perforate; aperture a low interiomarginal arched opening surrounded by a pronounced lip, situated halfway between the umbilicus and the periphery along inner margin of the last-formed chamber.

Discussion.—Most specimens of *Gyroidina*? *regularis* from the study area have a deep and narrow umbilical pit. This pit has been observed in Recent as well as Pliocene specimens from other areas. However, a few individuals possess a thin calcite covering over the umbilicus.

SEM photographs of several specimens with an open umbilical pit show openings, at the proximal end of the chambers, which open into this pit—suggesting secondary apertures. No apertural flaps were observed. I presently interpret the openings to be erosional or due to dissolution of the calcite—possibly as a result of using Quaternary "O" in the washing process.

Additional studies of *Gyroidina*? *regularis* from the Recent of the Gulf of Mexico may disclose the true apertural characteristics and the nature of the umbilical covering. This species will be included as part of my ongoing investigation of Recent benthic foraminifers from the Gulf of Mexico.

Gyroidina? *regularis* lacks the single interiomarginal aperture extending from the periphery to the umbilicus, which is characteristic of *Gyroidinoides* Brotzen, sensu Loeblich and Tappan (1964a, p. C750).

Gyroidella planata Saidova, 1975, differs from *Gyroidina*? *regularis* in its much larger size (almost twice the diameter) and in possessing an umbilicus filled with calcite. Saidova is unclear in her description as to whether the calcite is a solid plug or a covering over an umbilical pit.

Gyroidina? *regularis* is placed provisionally in the genus *Gyroidina* d'Orbigny herein because the exact nature of the aperture is unclear.

Distribution.—*Gyroidina*? *regularis* was described from the Holocene of the Gulf of Mexico. It is also recorded from the Holocene of the Caribbean, Pleistocene of the Gulf of Mexico, and Neogene of Aruba. It is rare in the Concepcion and Encanto "biozones".

Gyroidina umbonata (Silvestri, 1898)
Plate 33, figure 3

Rotalia soldanii d'Orbigny var. *umbonata* Silvestri, 1898, p. 239, pl. 6, figs. 14a–c.

Gyroidina parva Cushman and Renz, 1941, p. 23, pl. 4, figs. 2a–c.

Gyroidina nipponica Ishizaki, 1944, p. 102, pl. 3, figs. 3a–c.

Gyroidina umbonata (Silvestri). Agip Mineraria, 1957, p. 49, fig. 3; Parker, 1958, p. 266, pl. 3, figs. 19–20; Dieci, 1959, p. 78, pl. 6, fig. 25.

Gyroidina sp. A. Todd and Brönnimann, 1957, p. 37, pl. 11, figs. 5a–c.

Gyroidina cf. *neosoldanii* Brotzen. Drooger and Kaasschieter, 1958, p. 48, pl. 3, figs. 2a–c (not Brotzen, 1936).

Eponides tumidulus (Brady). Schnitker, 1971, p. 198, pl. 9, figs. 1a–c (not *Truncatulina tumidulus* Brady, 1884).

Description.—Test free, small, trochospiral, biconvex, spiral side slightly convex, umbilical side strongly convex, circular in outline with broadly-rounded periphery; chambers inflated, five to six in the last whorl, gradually increasing in size as added; sutures distinct, depressed, oblique on the spiral side, radial on the umbilical side; wall smooth, calcareous, hyaline, finely perforate; aperture an interiomarginal slit extending from a depression in the apertural face near the periphery to the umbilicus, with a distinct lip.

Discussion.—*Gyroidina quinqueloba* Uchio, 1960, from the Holocene off California, is similar and may be a junior synonym.

Distribution.—*Gyroidina umbonata* was described from the early Pliocene of Italy. It is also recorded from the Holocene of the Atlantic and Caribbean, and as *G. parva* from the Tertiary of Aruba, southern Spain, and Colombia; and the middle to late Miocene (Pozon Formation) of Venezuela. *Gyroidina umbonata* is rare to common in the Concepcion "biozone" and rare in the Encanto "biozone".

Genus **ORIDORSALIS** Andersen, 1961

Oridorsalis stellatus (Silvestri, 1898)
Plate 33, figures 4–5

Truncatulina tenera? Brady var. *stellata* Silvestri, 1898, p. 297, pl. 6, figs. 9a–c.

Rotalina ecuadorensis Galloway and Morrey, 1929, p. 26, pl. 3, figs. 13a–c.

Eponides umbonatus (Reuss) var. *ecuadorensis* (Galloway and Morrey). Hedberg, 1937, p. 679, pl. 91, fig. 22; Renz, 1948, p. 133, pl. 12, figs. 25a–b; Bermudez, 1949, p. 249, pl. 17, figs. 25–27; Becker and Dusenbury, 1958, p. 39, pl. 5, figs. 3a–c.

Eponides umbonatus (Reuss) var. *stellatus* (Silvestri). Agip Mineraria, 1957, pl. 41, fig. 1.

Oridorsalis westi Andersen, 1961, p. 107, pl. 22, figs. 3a–c.
Oridorsalis umbonatus ecuadorensis (Galloway and Morrey). Akers and Dorman, 1964, p. 46, pl. 10, figs. 36, 37.

Description.—Test free, small, a low trochospiral coil, biconvex, peripheral margin carinate with a distinct keel, circular in side view, last few chambers lobate; chambers distinct, five to six in the last whorl, all chambers visible on the spiral side, increasing gradually in size as added, slightly inflated, the ultimate chamber projecting into the center of the test on the umbilical side; sutures radial on the spiral side, sigmoid on the umbilical side, forming a distinct bend or kink near the distal end with the convex portion pointing in the direction of the earlier chambers, slightly depressed on the umbilical side; wall smooth, calcareous, hyaline, finely perforate; primary aperture an interiomarginal opening, extending from the umbilicus to the periphery, with a lip; supplementary apertures on the spiral side small, on the proximal end of the sutures between the ultimate and penultimate chambers; a small, closed aperture between the penultimate and antepenultimate chambers on some specimens; an additional larger supplemental aperture on umbilical side at the end of a projection of ultimate chamber into the umbilical area.

Discussion.—This species has generally been assigned to *Eponides ecuadorensis* (Galloway and Morrey, 1929) but in the European literature a similar form, *Eponides stellatus* (Silvestri, 1898) appears identical and is, therefore, a senior synonym. Examination of topotype material from Italy further shows that *E. stellatus* belongs to the genus *Oridorsalis* Andersen, 1961, which possesses supplementary apertures along the sutures.

Examination of topotype material of *Oridorsalis westi* Andersen, 1961, from the Mississippi River "mudlumps" showed this species to be conspecific with *O. stellatus* (Silvestri).

Loeblich and Tappan (1964a, p. C750) noted that the original description of *Oridorsalis* did not mention the secondary sutural openings on the umbilical side, which are visible on the type figure of *O. westi.*

Distribution.—*Oridorsalis stellatus* was described from the early Pliocene of Italy. It is recorded from the Pleistocene of the Gulf of Mexico; Tertiary of Ecuador, Colombia, Cuba, and Haiti; late Miocene to early Pliocene (Gurabo Formation) of the Dominican Republic; middle to late Miocene (Pozon and Cubagua formations) of Venezuela. It is rare in the Concepcion and Encanto "biozones".

Oridorsalis umbonatus (Reuss, 1851)

Plate 33, figure 6; Plate 34, figures 1–2

Rotalina umbonata Reuss, 1851, p. 75, pl. 5, figs. 35a–c.
Truncatulina tenera Brady, 1884, p. 665, pl. 95, figs. 11a–c.
Eponides umbonatus (Reuss). Bermudez, 1949, p. 249, pl. 17, figs. 22–24.
Eponides? *tenera* (Brady). Barker, 1960, p. 216, pl. 105, figs. 2a–c.
Pseudoeponides umbonatus (Reuss). Belford, 1966, p. 172, pl. 30, figs. 1–6.
Oridorsalis umbonatus (Reuss). Todd and Low, 1976, p. 23, pl. 6, figs. 10a–c.

Description.—Test free, trochospiral, biconvex, peripheral margin carinate with a distinct keel, circular in side view, last few chambers lobate; chambers distinct, five in the last whorl, all visible on the spiral side, increasing gradually in size as added, slightly inflated, the ultimate chamber projecting into the center of the test on the umbilical side; sutures limbate, radial on the spiral side, curved to radial on the umbilical side, slightly depressed in the last few chambers; wall calcareous, hyaline, finely perforate, smooth, except for some fine spines in front of the primary aperture on the umbilical side of test; primary aperture an interiomarginal slit with a thin lip extending from the umbilical area to the periphery; supplemental apertures on the spiral side are small openings on the proximal end of the sutures between the ultimate and penultimate chambers and the penultimate and antepenultimate chambers; the supplemental apertures on the umbilical side are located along the suture between the ultimate and penultimate chambers, and at the end of projection of the ultimate chamber into the umbilical area.

Discussion.—*Oridorsalis umbonatus* (Reuss, 1851) differs from *Oridorsalis stellatus* (Silvestri, 1898) in its thinner keel, curved rather than hooked sutures on the umbilical side, a larger primary aperture and a less developed extension of the ultimate chamber into the umbilicus.

Distribution.—*Oridorsalis umbonatus* was described from the Tertiary of Germany. It is recorded from the Holocene of the Atlantic, Pacific, and Gulf of Mexico; Pleistocene of the Gulf of Mexico; Tertiary of Japan, Haiti, Papua New Guinea, Mallorca (Mediterranean Sea); Neogene (Shimajiri Formation) of Okinawa; late Oligocene (Trinchera Formation) of Dominican Republic; late Miocene to early Pliocene (Bowden Formation) of Jamaica; middle Miocene (Carenero Formation) of Venezuela. It is rare in the Concepcion "biozone", and rare to common in the Encanto "biozone".

Family **OSANGULARIIDAE**

Loeblich and Tappan, 1964a

Genus **GYROIDINOIDES** Brotzen, 1942

Gyroidinoides altiformis (Stewart and Stewart, 1930)

Plate 34, figure 3

Gyroidina soldanii d'Orbigny var. *altiformis* Stewart and Stewart, 1930, p. 67, pl. 9, figs. 2a–c.
Gyroidina soldanii altiformis Stewart and Stewart. Coryell and Rivero, 1940, p. 337, pl. 43, figs. 19a–c.
Gyroidina altiformis Stewart and Stewart. Bermudez, 1949, p. 251, pl. 17, figs. 64–66; LeRoy, 1964, p. 37, pl. 7, figs. 7–9; Todd and Low, 1976, p. 22, pl. 5, figs. 14a–c.
Gyroidina neosoldanii Brotzen var. *acuta* Boomgaart, 1949, p. 125, pl. 14, figs. 1a–c.
Gyroidinoides soldanii altiformis Stewart and Stewart. Parker, 1954, p. 527, pl. 9, figs. 7, 8.
Gyroidinoides altiformis Stewart and Stewart. Becker and Dusenbury, 1958, p. 38, pl. 5, figs. 1a–c.

Description.—Test free, trochospiral, planoconvex, spiral side flat to slightly convex, umbilical side convex with deep umbilicus, circular in outline; peripheral edge subacute; nine to ten chambers in last whorl, inflated on the umbilical side, slightly depressed on the spiral side; sutures distinct, limbate, slightly depressed and radial on the umbilical side, raised and oblique on the spiral side; wall calcareous, hyaline, smooth, finely perforate; aperture a low interiomarginal slit extending from periphery to umbilicus; umbilicus with several umbilical flaps projecting from last few chambers into the umbilicus.

Discussion.—*Gyroidinoides soldanii* d'Orbigny, 1826, differs from *G. altiformis* in having flush radial sutures on the spiral side rather than raised oblique sutures.

Distribution.—*Gyroidinoides altiformis* was described from the early Pliocene of California. It is recorded from the Holocene of the Gulf of Mexico, Mediterranean, and Atlantic; Pleistocene of the Gulf of Mexico; Tertiary of the Dominican Republic, Colombia, and Haiti; middle to late Miocene (Cubagua Formation) of Venezuela; and Oligo-Miocene (Juana Diaz Formation) of Puerto Rico. This species is rare in the lower Concepcion "biozone" but common to abundant in the Encanto "biozone".

Genus **OSANGULARIA** Brotzen, 1940

Osangularia culter (Parker and Jones, 1865)
Plate 34, figure 6

Planorbulina farcta (Fichtel and Moll) var. *ungeriana* (d'Orbigny) subvar. *culter* Parker and Jones, 1865, pp. 382, 421, pl. 19, figs. 1a–b.
Pulvinulinella culter (Parker and Jones). Cushman, 1929a, p. 100, pl. 14, figs. 13a–c.
Pulvinulinella culter (Parker and Jones). Colom, 1946b, p. 59, pl. 4, figs. 115–116.
Parrella culter (Parker and Jones). Hofker, 1951, p. 336, text-figs. 229–232.
Osangularia cultur [*sic*] (Parker and Jones). Parker, 1954, p. 530, pl. 9, figs. 29, 30.
Osangularia culter (Parker and Jones). Belford, 1966, p. 175, pl. 35, figs. 1–5; Todd and Low, 1976, p. 23, pl. 6, figs. 3a–c.

Description.—Test free, trochospiral, unequally biconvex, the umbilical side more convex than the spiral side; periphery carinate; chambers distinct, slowly increasing in size as added, inflated on umbilical side, nine chambers in final whorl, all visible on spiral side; sutures distinct, depressed and radial on the umbilical side, raised and oblique on the spiral side; wall calcareous, hyaline, smooth, finely perforate; aperture an interiomarginal slit along base of ultimate chamber on umbilical side, extending at an oblique angle up the apertural face, sometimes with a horizontal areal slit with lip separated from primary aperture.

Discussion.—*Osangularia bengalensis* (Schwager, 1866) differs from *O. culter* in its more biconvex test, more chambers per whorl and more refined sutures.

Distribution.—*Osangularia culter* was described from the Holocene of the central Atlantic. It is recorded from the Holocene of the Gulf of Mexico, Pacific; Neogene of Papua New Guinea and Mallorca; Oligo-Miocene (Juana Diaz Formation) of Puerto Rico; and early Miocene (San Lorenzo Formation) of Venezuela. It is rare in the Encanto "biozone", occurring only at localities PD-52, 68 and 70.

Family **ANOMALINIDAE** Cushman, 1927a

Subfamily **ANOMALININAE** Cushman, 1927a

Genus **ANOMALINOIDES** Brotzen, 1942

Anomalinoides nucleatus (Seguenza, 1880)
Plate 35, figure 1

Truncatulina nucleata Seguenza, 1880, p. 64, pl. 7, fig. 8.
Truncatulina trinitatensis Nuttall, 1928, p. 97, pl. 7, figs. 3, 5, 6.
Cibicides nucleata (Seguenza). Galloway and Morrey, 1929, p. 31, pl. 4, fig. 9.
Cibicides trinitatensis (Nuttall). Nuttall, 1932, p. 33, pl. 7, fig. 9; Hadley, 1934, p. 29, pl. 4, figs. 10, 11.
Anomalina nucleata (Seguenza). Coryell and Rivero, 1940, p. 334, pl. 44, figs. 2a–c.
Anomalinoides trinitatensis (Nuttall). Renz, 1948, p. 115, pl. 10, figs. 11a–c.
Cibicides nucleatus (Seguenza). Bermudez, 1949, p. 303, pl. 24, figs. 16–18; Akers and Dorman, 1964, p. 30, pl. 15, figs. 21–23.
Cibicides robustus Phleger and Parker, 1951, p. 31, pl. 17, figs. 1–4 (homonym of *C. robustus* LeCalvez, 1949).
Cibicides corpulentus Phleger and Parker, 1952 (*nom. nov.*), p. 14; Parker, 1954, p. 541, pl. 12, figs. 4, 8.
Anomalinoides corpulentus (Phleger and Parker). LeRoy and Levinson, 1974, p. 16, pl. 8, figs. 4, 5, 6.

Description.—Test free, large, trochospiral, biconvex, periphery rounded, circular in side view; spiral side with thick clear plug of shell material obscuring the earlier whorls, surrounded by a deep channel; chambers numerous, 14 to 15 in the final whorl; sutures distinct, limbate, raised, slightly curved on spiral and umbilical sides; wall calcareous, hyaline, coarsely perforate, except for a small area near center of test on umbilical side; aperture a low interiomarginal arch with a narrow lip, extending along the spiral suture to channel surrounding the raised plug.

Discussion.—Akers and Dorman (1964, pp. 30–31) compared the holotype of *Cibicides corpulentus* Phleger and Parker, 1952, from the Holocene of the Gulf of Mexico with specimens they assigned to *C. nucleatus* Seguenza, 1880, from the Tertiary of the Caribbean. They observed that the size of the umbo and limbation of sutures were variable and concluded that *C. corpulentus* was a synonym of *C. nucleatus.* This rationale is also used in this study.

Distribution.—*Anomalinoides nucleatus* (Seguenza) was described from the Miocene of Italy. It is also recorded from the Holocene and Pleistocene of the Gulf of Mexico, Tertiary of Cuba and Haiti; early Miocene (St. Croix Formation) of Trinidad, Manta Formation of Ecuador, late Oligocene (Alazan Formation) of Mexico, Miocene (Pozon and San Lorenzo formations) of Venezuela, the late Miocene to early Pliocene (Gurabo Formation) of the Dominican Republic, and the late Miocene to early Pliocene (Bowden Formation) of Jamaica.

This species is not mentioned in the literature on Pacific occurrences and therefore may be restricted to the Atlantic province. It is found only in the Encanto "biozone" of the study area and is one of the key species for identification of this "biozone".

Genus **CIBICIDOIDES** Thalmann, 1939

Cibicidoides floridanus (Cushman, 1918)

Plate 35, figure 2

Truncatulina floridana Cushman, 1918b, p. 62, pl. 19, fig. 2.

Cibicides floridanus (Cushman). Cushman, 1930, p. 61, pl. 12, figs. 3a–c; Galloway and Heminway, 1941, p. 392, pl. 23, figs. 2a–c.

Cibicides aff. *floridanus* (Cushman). Phleger and Parker, 1951 (part), p. 30, pl. 16, figs. 1a–b (not figs. 3–4).

Cibicidoides floridanus (Cushman). LeRoy and Levinson, 1974, p. 16, pl. 8, figs. 7–9.

Description.—Test free, trochospiral, biconvex in edge view, subcircular in side view, peripheral margin subacute; ten to 11 chambers in the final whorl, chambers of earlier whorls obscured by secondary calcite on the spiral side; sutures on umbilical side raised, limbate and curved, those on spiral side curved, limbate and raised except for last few chambers, in which they are flush or depressed; wall calcareous, hyaline, smooth, coarsely perforate; aperture a low interiomarginal arch with a slight projecting lip, extending across the periphery to the spiral side and continuing along the spiral suture the length of two or three chambers.

Discussion.—*Cibicidoides floridanus* differs from *C. umbonatus* Phleger and Parker, 1951, in possessing a thick calcite covering on the spiral side that obscures the chambers of the early whorls.

C. W. Poag (written commun., 1982) has looked at topotype material from the Miocene of Florida and concludes that true *C. floridanus* does not exist in the present Gulf of Mexico. Poag (1981) differentiated paired ecophenotypes that he termed *Cibicidoides* "*floridanus*" forma *bathyalis* and *C.* "*f.*" forma *sublittoralis.* He separated these forms based on size and thickness of the wall. Forma *bathyalis,* the larger and thicker-walled form, he reports as common in the slope facies, while forma *sublittoralis* occurs in the shallow-water shelf-edge facies.

Pflum and Frerichs (1976), however, recognized *C. floridanus* occurrences in several Gulf of Mexico traverses. I consider forms found in the study herein to closely fit *C. floridanus* (Cushman), and I place *C.* "*f.*" forma *bathyalis* in synonymy with *C. floridanus.* There is no intergradation within the Pliocene population of *C. floridanus* in the study area such as Poag (1981) observed for the Recent Gulf of Mexico.

Distribution.—*Cibicidoides floridanus* was described from the Miocene (Choctawhatchee Formation) of Florida. It is recorded from the Holocene and Pleistocene of the Gulf of Mexico; Oligocene to Pliocene (Ponce, Cibao, and Quebradillas formations) of Puerto Rico; Neogene of Haiti, and Italy. It is common to abundant at most localities in the Concepcion and Encanto "biozones".

Cibicidoides miocenica (Colom, 1946)

Plate 35, figure 3

Cibicides floridanus (Cushman). Cushman and Todd, 1945, p. 71, pl. 12, fig. 8 (not *Truncatulina floridana* Cushman, 1918b).

Cibicides floridanus (Cushman) subsp. *miocenica* Colom, 1946a, p. 173, pl. 12, figs. 248, 291, 295–297, 300, 303.

Cibicidoides miocenica (Colom). Sansores and Flores-Covarrubias, 1972b, p. 462, fig. 9.

Description.—Test free, trochospiral, biconvex, peripheral margin subacute, circular in side view, last few chambers slightly lobate; chambers numerous, ten to 12 in last whorl, gradually increasing in size as added; distinct keel on all but last three chambers; spiral side with only the last whorl visible, the previous whorls covered by numerous, raised pustules aligned along the sutures of the early chambers, completely obscuring the previous whorls, umbilical side with a clear calcite plug near center; sutures limbate, strongly curved on both the spiral and umbilical side, raised between all chambers on umbilical side, raised on all but last three chambers on spiral side; wall calcareous, hyaline, coarsely perforate; aperture an interiomarginal arch with distinct lip, continuing along spiral suture the length of two to three chambers.

Discussion.—*Cibicidoides matanzasensis* (Hadley, 1934) is similar to *C. miocenica,* but the type description fails to mention the pattern of the "beadlike structures". They are apparently randomly arranged in *C. matanzasensis,* as seen in the illustration of the type (Pl. 4, figs. 1–3). This species is also only one-half the size of *C. miocenica.* The ornamentation of *Cibicidoides miocenica* is described as restricted to the sutures of the chambers exclusive of the final whorl. The specimen figured as *C. matanzasensis* by Bermudez (1949) is probably *C. miocenica,* but Bermudez does not mention the ornamentation in his remarks. On this basis, *C. matanzasensis* as described by Bermudez (1949) is excluded from the present concept of *C. miocenica.*

Distribution.—Cibicidoides miocenica was described from the Neogene of Mallorca. It also occurs in the late Miocene to early Pliocene (Bowden Formation) of Jamaica. It is rare to common in the Encanto "biozone".

Cibicidoides robertsonianus (Brady, 1884)
Plate 35, figure 4

Truncatulina robertsoniana Brady, 1884, p. 664, pl. 95, fig. 4.
Cibicides robertsoniana (Brady). Cushman, 1931, p. 121, pl. 23, figs. 6a–c; Phleger and Parker, 1951, p. 31, pl. 16, figs. 10a–b, 11a–b, 12a–b, 13a–b; Parker, 1954, p. 543, pl. 13, figs. 2, 5; Agip Mineraria, 1957, pl. 52, figs. 3a–c; Todd and Low, 1976, p. 22, pl. 8, figs. 2a–c.
Cibicidoides robertsonianus (Brady). LeRoy and Levinson, 1974, p. 16, pl. 8, figs. 10, 11.

Description.—Test free, small, trochospiral, biconvex; peripheral margin rounded, circular in side view; chambers increasing gradually in size as added, slightly inflated, six to seven in final whorl, all visible on spiral side; sutures distinct, slightly curving on umbilical side and slightly depressed, oblique on spiral side; wall calcareous, hyaline spiral side coarsely perforate, umbilical side imperforate; aperture an interiomarginal arch with a distinct lip, continuing along the spiral suture.

Discussion.—The specimens from the study area are much smaller and have fewer chambers in the last whorl than the figured type of *C. robertsonianus* (Brady), but are considered herein to be within the range of variation of this species.

Distribution.—Cibicidoides robertsonianus was described from the Holocene of the West Indies. It is recorded from the Holocene of the Atlantic, Gulf of Mexico, and Caribbean; Pleistocene of the Gulf of Mexico; Tertiary of Italy; and Oligo-Miocene (Juana Diaz Formation) of Puerto Rico. It is rare in the Encanto "biozone", only occurring at localities PD-68, 70.

Cibicidoides umbonatus (Phleger and Parker, 1951)
Plate 35, figure 5–6

Cibicides umbonatus Phleger and Parker, 1951, p. 31, pl. 17, figs. 7–8, 9a–b; Parker, 1954, p. 543, pl. 12, figs. 17–18; Akers and Dorman, 1964, p. 31, pl. 15, figs. 7, 8.

Description.—Test free, trochospiral, biconvex, subcircular and slightly lobate in side view, periphery angular with a narrow, thickened keel; umbo of clear shell material at center of umbilical side; chambers distinct, nine to 11 in the final whorl, increasing gradually in size, all chambers visible on spiral side; sutures oblique on the spiral side, flush with surface, slightly curved and depressed on umbilical side; wall calcareous, hyaline, smooth, coarsely perforate; aperture an interiomarginal equatorial arch with a slight lip, extending along the spiral suture the length of one to two chambers.

Discussion.—Cibicidoides umbonatus differs from *Cibicidoides floridanus* (Cushman, 1918b) in its smaller size, transparent spiral side with all chambers visible, and less oblique sutures on the umbilical side.

Distribution.—Cibicidoides umbonatus was described from the Holocene of the Gulf of Mexico. It is also reported from the Pleistocene of the Gulf of Mexico. This species is rare to common in the Encanto "biozone".

Genus **HANZAWAIA** Asano, 1944

Hanzawaia concentrica (Cushman, 1918)
Plate 36, figure 1

Truncatulina concentrica Cushman, 1918b, p. 64, pl. 21, figs. 3a–c.
Cibicides concentricus (Cushman). Renz, 1948, p. 127, pl. 10, figs. 8a–c; Bermudez, 1949, p. 296, pl. 26, figs. 7–12; Phleger and Parker, 1951, p. 29, pl. 15, figs. 14–15.
Hanzawaia concentrica (Cushman). Puri, 1953, p. 140, pl. 12, figs. 7–9; Akers and Dorman, 1964, p. 37, pl. 15, figs. 3–4; Smith, 1964, p. 44, pl. 6, figs. 2a–c.
Hanzawaia concentrica (Cushman) forma *typica.* Poag, 1981, p. 68, pl. 39, fig. 1, pl. 40, fig. 1.

Description.—Test free, trochospiral, planoconvex to unequally biconvex, spiral side flattened and partially evolute, ventral side convex and involute; periphery angular with slight keel; chambers inflated, nine in the final whorl, increasing rapidly in size as added; each chamber on spiral side with an imperforate flap on inner margin projecting into the central area and merging to form an imperforate circular ring surrounding the umbilical area, openings at each suture surrounding the outer margin of ring; sutures distinct, slightly curved on spiral and ventral side, slightly depressed between later chambers on ventral side; wall calcareous, hyaline, smooth, finely perforate, except for apertural face and umbilical extension on spiral side; aperture an arch on the periphery with a distinct lip, extending to spiral side under the central ring surrounding umbilical area, supplemental openings along sutures at outer margin of ring.

Discussion.—Hanzawaia concentrica differs from *H. strattoni* (Applin, 1925) in its more acute, keeled periphery and flattened spiral side, and from *Hanzawaia nipponica* Asano, 1944, in possessing radial sutures and a more inflated test.

Distribution.—Hanzawaia concentrica was described from the Miocene (Choctawhatchee Formation) of Florida. It is recorded from the Holocene of the Pacific, Atlantic, Caribbean, and Gulf of Mexico; Pleistocene of the Gulf of Mexico; Tertiary of Haiti and Cuba; late Pliocene (Jimani Formation) of the Dominican Republic. This species is abundant to common in the upper Concepcion "biozone", rare in the lower Concepcion and Encanto "biozones" of the study area.

Hanzawaia isidroensis (Cushman and Renz, 1941)
Plate 36, figure 2

Cibicides isidroensis Cushman and Renz, 1941, p. 26, pl. 4, fig. 10; Renz, 1948, p. 128, pl. x, figs. 10a–c; Drooger, 1953, p. 145, pl. 22, fig. 16.

Valvulineria crassisepta Keijzer, 1945, p. 203, pl. 4, fig. 56.

Hanzawaia isidroensis (Cushman and Renz). Sansores and Flores-Covarrubias, 1972b, pl. 10, figs. 7a–b.

Description.—Test free, trochospiral, nearly equally biconvex, ventral side more elevated, periphery subacute, lobate in side view, chambers slightly inflated, eight to nine in final whorl, increasing rapidly in size as added; sutures distinct on both sides, limbate, strongly curved, thickened toward inner end, slightly raised; calcareous, hyaline, finely perforate, smooth; aperture a low-arched opening on spiral side near periphery, continuous with opening on spiral side, under plate formed by the fusing of the apertural flaps, supplementary openings around outer margin of plate.

Discussion.—This species is similar to *Hanzawaia carstensi* (Cushman and Ellisor, 1939) but has a more angular periphery and fewer chambers in the last whorl.

Distribution.—Hanzawaia isidroensis was described from the Miocene of Venezuela. It is also recorded from the Neogene of Cuba, Aruba, and Mexico; and middle Miocene (Carenero Formation) of Venezuela. This species is rare to common in the Concepcion "biozone" and rare in the Encanto "biozone".

Hanzawaia strattoni (Applin, 1925)
Plate 36, figure 3

Truncatulina americana Cushman var. *strattoni* Applin, *in* Applin, Ellisor, and Kniker, 1925, p. 99, pl. 3, fig. 3.

Cibicidina strattoni (Applin). Parker, 1954, p. 544, pl. 13, figs. 8, 11.

Hanzawaia strattoni (Applin). Bandy, 1954, p. 136, pl. 31, fig. 4; Akers and Dorman, 1964, p. 37, pl. 15, figs. 13–14.

Hanzawaia concentrica (Cushman) forma *strattoni* (Applin). Poag, 1981, p. 67, pl. 39, fig. 2, pl. 40, fig. 2.

Description.—Test free, trochoid, nearly equally biconvex, ventral side slightly involute, periphery rounded, lobate in side view, chambers inflated, eight chambers in final whorl, increasing in size rapidly as added, chambers on spiral side have imperforate flaps on inner margin of each chamber that merge, covering entire umbilicus; openings occur along the inner margin of each chamber near the suture; sutures distinct, depressed between the last few chambers on spiral and ventral sides, slightly curved to radial; wall calcareous, hyaline, smooth, perforate, except for the flaps on spiral side, which are imperforate; aperture an interiomarginal arch on the periphery with a distinct lip, extending to spiral side under the apertural flaps, supplementary openings on spiral side, along the sutures and outer margin of the central umbilical ring.

Discussion.—Hanzawaia strattoni differs from *H. concentrica* (Cushman, 1918b) in its more equally biconvex test and in possessing a rounded periphery with no keel.

Akers and Dorman (1964, p. 37) observed that a gradation between *H. concentrica* (Cushman) and *H. strattoni* (Applin) may exist. More recently, Poag (1981, p. 68) wrote that "forma *strattoni* appears to be an ecophenotypic variant of *H. concentrica* forma *typica*" but he did not figure intermediate forms.

Since populations of *Hanzawaia* from the shallow water facies in the study area are dominated by *H. concentrica* and gradations between *H. concentrica* and *H. strattoni* were not observed, the two forms are regarded here as distinct species.

Additional studies of Recent and Pliocene populations may provide the evidence needed to place *H. concentrica* and *H. strattoni* in a morphoseries.

Distribution.—Hanzawaia strattoni was described from the Miocene of the subsurface of Louisiana. It is recorded from the Holocene and Pleistocene of the Gulf of Mexico, and Holocene of the Caribbean. This species is restricted to the upper Concepcion "biozone" and is rare at localities SD-21 and PD-39 in the study area.

Genus **MELONIS** Montfort, 1808

Melonis affinis (Reuss, 1851)

Plate 36, figure 4

Nonionina affinis Reuss, 1851, p. 72, pl. 5, figs. 32a–b.
Nonionina barleeana Williamson, 1858, p. 32, pl. 3, figs. 68–69.
Nonionina formosa Seguenza, 1880, p. 63, pl. 7, fig. 6.
Nonion planatum Cushman and Thomas, 1930, p. 37, pl. 3, fig. 5.
Nonion nicobarense Cushman, 1936b, p. 67, pl. 12, fig. 9.
Nonion affine (Reuss). Renz, 1948, p. 148, pl. 6, figs. 3a–b; Smith, 1964, p. 41, pl. 4, figs. 1a–b.
Nonion parkerae Uchio, 1960, p. 60, pl. 4, figs. 9–10.
Melonis affinis (Reuss). Belford, 1966, p. 184, pl. 31, figs. 1–4.

Description.—Test free, planispiral, biconvex, compressed, symmetrical and involute, deeply biumbilicate; periphery rounded, nearly circular in side view; chambers distinct, ten to 13 in the last whorl, gradually increasing in size as added, not inflated, each chamber ending at the umbilical region in a slightly thickened limbate flap that overhangs the open umbilicus; sutures limbate, flush with surface, slightly curved, fused into an imperforate ring around the umbilicus; wall calcareous, hyaline, smooth, coarsely perforate, except for the imperforate umbilical rim, umbilical flaps, and apertural face; aperture a low-arched interiomarginal equatorial slit, extending laterally from one umbilicus to the other.

Discussion.—Boltovskoy (1958, p. 195) examined topotypes of *Melonis affinis* (Reuss, 1851) from the Eocene of Germany. He noted that there were ten to 11 chambers in the last whorl and that the sutures were limbate and became wider near the umbilicus where they form a "circle of varying size at the circumference". These observations broaden the description of Reuss (1851), and support the inclusion of many additional species in the synonymy of *M. affinis.* Belford (1966, p. 184) noted that his Papua New Guinea specimens had 11 to 14 chambers but considered the observed differences between his material and the topotypes of *M. affinis* to be too small to require the assignment of a new specific name.

Distribution.—*Melonis affinis* was described from the Paleogene of Germany. It is recorded from the Holocene of the Pacific, Atlantic, Caribbean and Gulf of Mexico; Pleistocene of the Gulf of Mexico; Neogene of Texas, Mexico, Ecuador, and Papua New Guinea; middle to late Miocene (Pozon Formation) of Venezuela. It is rare to common in the Encanto "biozone".

APPENDIX

COLLECTING LOCALITIES

Samples from the following localities were collected by the author in March, 1975. The marine outcrop material generally ranges in color from brown to blue-gray when fresh, and weathers to a light brown. The fossil content described here was determined in the field with the aid of a hand lens. Kilometer markers are designated KM.

Sayula Dome

SD-1	South end of roadcut at KM-4, 4 km south of Acayucan, Veracruz, on west side of Highway #185. No bedding visible.
SD-2	Approximately 17 m north of SD-1 on east side of Highway #185, south of Acayucan, Veracruz. Sampled near center of roadcut, 1 m from base of cut, which is approximately 3 m high.
SD-3	Approximately 4.5 km south of Acayucan, Veracruz, from a roadcut on west side of Highway #185. Sampled at base of cut, which is approximately 7 m high. Fossiliferous silty clay with limestone nodules and abundant echinoid spines up to 3 cm in length.
SD-4	South end of roadcut on west side of Highway #185, approximately 4.5 km south of Acayucan, Veracruz. Taken at base of cut, 13 m south of SD-14. Fossiliferous silty clay with echinoid spines and calcareous nodules (=loc. TU 1083).
SD-5	Roadcut on west side of Highway #185, 5.01 km south of Acayucan, Veracruz. Collected approximately 2 m from base of roadcut, which is 100 m south of "Rancho Santa Rita". Roadcut is 3 m high, sampled near middle of cut. Sediment is a silty clay, kaolinitic, cream-colored to gray. Apparent dip of beds approximately 30° north.
SD-6	Roadcut 30 m south of KM-6, 6.03 km south of Acayucan, Veracruz on Highway #185. Taken from west side of highway, from roadcut 5 m high, 1 m from base. Fossiliferous and kaolinitic (=loc. TU 1139).
SD-7	Base of roadcut, west side of Highway #185, 5.5 km south of Acayucan, Veracruz. Sample is a very fine-grained clayey siltstone.
SD-8	Same roadcut as SD-7, at northern limit of cut on west side of Highway #185, 5+ km south of Acayucan, Veracruz.
SD-9	Northernmost end of roadcut, 3 m south of driveway on west side of Highway #185, approximately 4.5 km south of Acayucan, Veracruz. Collected at base of cut with an auger. A silty clay, no bedding noticeable, fossiliferous.
SD-10	About 10 m south of SD-9 at base of roadcut, sampled with auger.
SD-11	About 13 m south of SD-10, base of roadcut.
SD-12	About 15 m south of SD-3 at base of roadcut on west side of Highway #185. Approximately 4.5 km south of Acayucan, Veracruz.
SD-13	Base of roadcut, 13 m south of SD-12.
SD-14	Base of roadcut, 13 m south of SD-13.
SD-15	Near southern end of roadcut, 40 m south of SD-4, approximately 4.5 km south of Acayucan, Veracruz. Roadcut 1 m high, sample taken with auger near top.
SD-16	About 0.25 km south of KM-10, along Highway #185, 0.5 km south of Sayula, Veracruz. Sample from excavated roadcut on west side of highway. Buff-colored siltstone, weathers to gray, interbedded with grayish clays. Distinct bedding, apparent dip of 10° south.
SD-17	Roadcut 0.75 km south of KM-10, east side of Highway #185, south of Sayula, Veracruz. Roadcut 10 m high, sampled 3 m from base, below powerline pole. Bedding visible, strata dip to south. Material a blocky clay with lenses of siltstone and medium sand.

SD-18	Roadcut south of KM-11, south of Sayula, Veracruz. Sampled from east side of Highway #185. Roadcut 5 m high. Sample taken from 1 m above base, below powerline pole. Silty clay, weathers blocky, fossiliferous (=loc. TU 1140).
SD-19	Large excavation in roadcut on east side of Highway #185, 0.75 km south of KM 11. Sampled below powerline pole #4. Massive sand, fine-grained with silty stringers.
SD-20	Roadcut west side of Highway #185 just south of KM-12, 12 km south of Acayucan, Veracruz. Roadcut 10 m high, sampled 2 m from base across from X-braced powerline pole, just north of "Rancho San Luis" at top of hill.
SD-21	Excavation on east side of Highway #185, 20 m south of KM-13. A massive silty clay.
SD-22	Roadcut, west side of Highway #185, across from "Rancho el Jaibolito", 13.75 km south of Acayucan, Veracruz. Roadcut 7 m high, sample taken 1 m above base.
SD-28	Excavated roadcut on west side of Highway #185, south of Sayula, Veracruz. Sampled approximately 100 m south of SD-22, 1 m above base of a 3-m high exposure. Clayey silt, buff to gray, micaceous, some bedding, fossil plant remains.
SD-29	Roadcut on west side of Highway #185, 14 km south of Sayula, Veracruz. First roadcut north of concrete bridge. Roadcut 10 m high, sampled 1 m from base near center of cut. Lithology similar to SD-28, weakly fossiliferous.
SD-30	Roadcut on west side of Highway #185, 0.25 km north of cross road at center of Sayula, Veracruz, approximately 9.25 km south of Acayucan. Sample from below a sandstone conglomerate in shale and sandstone sequence. Beds dipping steeply to south.
SD-31	Small bluff at "Rancho Maria Lorenza", approximately 100 m east of Highway #185, 0.25 km south of SD-15. Massive clay with no bedding visible.
SD-32	Roadcut on east side of Highway #185, 4 km south of Acayucan, Veracruz. Across highway from SD-1. Auger used for sampling.

Potrerillos Dome

Localities across the Potrerillos Dome were visited by Dr. W. A. van den Bold in August, 1982. He reports (written commun., 1982) that the ditches have been filled, making further collection impossible. However, alternative sampling by auger can be made at the same localities in the roadcut, above the level of the pavement.

PD-33	Roadcut approximately 16 km east of Acayucan, Veracruz, on Highway #180. Sampled from south side of highway near western end of exposure, from ditch approximately 1 m below pavement. Marine clay, fossiliferous (=loc. TU 1153).
PD-34	About 12 m east of PD-33, from ditch along roadcut on south side of Highway #180.
PD-35	Ditch along roadcut, south side of Highway #180, 12 m east of PD-34.
PD-36	Ditch approximately 1 m below level of pavement on south side of Highway #180, 16+ km east of Acayucan, Veracruz. Taken 5 m east of PD-35.
PD-37	Ditch 1 m below pavement on south side of Highway #180. Sampled 8 m east of PD-36.
PD-38	Ditch near eastern end of roadcut along Highway #180, 1 m below pavement, 35 m east of PD-37. South side of highway.
PD-39	Roadcut 5 m high on north side of Highway #180, 10.35 km east of Acayucan, Veracruz. Sampled 1 m above base. Fossiliferous, clayey silt, cream-colored with plant impressions.
PD-40	Excavation in roadcut, north of Highway #180, at extreme western end of cut, approximately 16 m east of dirt road to the village of Chogota. Sampled near base of excavation, a silty clay with foraminifers and leaf impressions.
PD-41	Roadcut on north side of Highway #180, 10.825 km east of Acayucan, Veracruz. Sample 1 m above base of cut, massive silty clay, brown with some small gravel.
PD-42	North side of Highway #180, just east of pipeline. Same roadcut as PD-41, 10.85 km east of Acayucan, Veracruz.
PD-43	Roadcut on south side of Highway #180, 11.075 km east of Acayucan, Veracruz. Sample from base of roadcut.
PD-44	Roadcut on south side of Highway #180, 12.175 km east of Acayucan, Veracruz. Sampled near the eastern limit of roadcut.
PD-45	Same roadcut, 55 m west of PD-44, on south side of Highway #180.
PD-46	Roadcut on north side of Highway #180, 12.64 km east of Acayucan, Veracruz. Sample from ditch at eastern end of roadcut. Fossiliferous clay.
PD-47	Roadcut on south side of Highway #180, approximately 1 km west of Jaltipan, Veracruz, and 19.2 km east of Acayucan. First roadcut east of Tehuantepec Railroad, 1 m from base of a 3-m high cut. Variegated brown sand, micaceous with clay stringers, no bedding observed.
PD-48	First roadcut west of Tehuantepec Railroad, on Highway #180, approximately 3 km west of Jaltipan, Veracruz, and 17.68 km east of Acayucan. Sampled on south side of highway, 1 m above base. Fossiliferous clay.
PD-49	Same roadcut as PD-48, from ditch 1 m below pavement, 30 m west of PD-48, 17.65 km east of Acayucan, Veracruz along Highway #180. Clay with plant impressions, fossiliferous.
PD-50	Sample 50 m west of PD-49 in same roadcut, south side of Highway #180. Taken from ditch.
PD-51	Roadcut on south side of Highway #180, 16.65 km east of Acayucan, Veracruz. Sample from ditch, 1 m below level of highway, fossiliferous, gray to green clay.
PD-52	Ditch, 15 m west of PD-51.
PD-53	Ditch, 10 m west of PD-52.
PD-54	Roadcut on north side of Highway #180, 11.85 km east of Acayucan, Veracruz. Sampled 1 m above base of cut near west end, across from house.
PD-55	Same roadcut as PD-54, 30 m east. Massive silty clay, few fossils.
PD-56	Roadcut on south side of Highway #180, 12.9 km east of Acayucan, Veracruz. Sample collected 1 m below highway pavement. Fossiliferous clay.
PD-57	Same roadcut 50 m west of PD-56. Collected at base of roadcut.
PD-58	Roadcut on north side of Highway #180, 13.3 km east of Acayucan, Veracruz. Sampled from ditch 1 m below pavement level near west end of cut. Very fossiliferous.
PD-59	South side of Highway #180, 60 m east of PD-58. Collected from base of cut near eastern end.
PD-60	Roadcut on south side of Highway #180, 13.72 km east of Acayucan, Veracruz. Sample taken about midway along cut and approximately 5 m above base—near top of cut. A blocky kaolinitic, chocolate-colored clay, very fossiliferous. Beds appear horizontal (=loc. TU 1151).

PD-61	Same location as PD-60, and immediately above and in contact with PD-60. Sample a white, altered ash bed, glauconitic, no foraminifers observed. Horizontal bedding.
PD-62	Roadcut on south side of Highway #180, 14.66 km east of Acayucan, Veracruz. Sample from excavation on eastern end of cut. Interbedded clays and altered ash beds, clays fossiliferous, excellent bedding, SE dip [Stop 2, Viniegra *et al.,* 1956, p. 167, La Laja Fm] (=loc. TU 1151).
PD-63	Base of roadcut on north side of Highway #180, toward middle of cut 9.65 km east of Acayucan, Veracruz. Brown clayey silt with plant impressions.
PD-64	Same roadcut, 10 m east of PD-63.
PD-65	Ditch on south side of Highway #180, just east of road to Texistepec, 9.9 km east of Acayucan, Veracruz. Collected from ditch, 1 m below pavement near western end of roadcut. Silty clay, fossiliferous.
PD-66	About 100 m east of PD-65 at KM-10. Collected from freshly-exposed material 2.5 m above base of cut. Silty clay with plant impressions, fossiliferous, good bedding.
PD-67	Roadcut on south side of Highway #180, 11.34 km east of Acayucan, Veracruz. Sampled at base of cut near eastern end.
PD-68	Roadcut on south side of Highway #180, 15.72 km east of Acayucan, Veracruz. Sampled near western end of cut, from ditch 1 m below pavement. Clay with some glauconite, very fossiliferous.
PD-69	Ditch, 30 m east of PD-68.
PD-70	Ditch, 25 m east of PD-69, 15.775 km east of Acayucan, Veracruz. Roadcut on south side of Highway #180.
PD-71	Ditch, 1 m below pavement, 50 m east of PD-70.
PD-72	Ditch, 25 m east of PD-71.
PD-76	Roadcut on south side of Highway #180, 14.94 km east of Acayucan, Veracruz. Sampled from ditch, 1 m below pavement, a marine clay, very fossiliferous.
PD-77	South side of Highway #180, 120 m west of PD-76. Collected along a path, not in a roadcut. Material weathered but fossiliferous.
PD-78	Ditch, 1 m below pavement and 40 m east of PD-76.
PD-79	Ditch, 40 m east of PD-78.
PD-81	Excavation on top of hill, 3 km north of Jaltipan, Veracruz, on west side of gravel road, 2.25 km north of railroad crossing. Sample taken 1 m above base of excavation, which is 3 m high. Greenish-gray clay, very fossiliferous.

Texistepec Anticline

TA-73	Outcrop on east side of gravel road to Texistepec, 6.25 km south of intersection with Highway #180, 1 km south of railroad crossing, north of town of Texistepec. A blocky kaolinitic clay, fossiliferous.
TA-74	Roadcut on east side of gravel road to Texistepec, 1.75 km south of railroad crossing. Approximately 0.50 km south of TA-73. Interbedded limestone, clays, altered ash beds, fossiliferous.
TA-75	Excavation on top of hill west side of gravel road to Texistepec, 1.5 km south of intersection with Highway #180. A micaceous, brown clayey silt.

Soconusco Anticline

SA-23	Roadcut on west side of Highway #180, 3 km north of the intersection of Highways #185 and #180, north of Acayucan. Sample from near crest of anticline, taken 3 m from base of cut, which is 5 m high. Silty clay with patches of iron stain.
SA-24	Same roadcut as SA-23, but 50 m south. Gray sandstone.
SA-25	Same roadcut as SA-24, but 20 m south. A conglomerate with interbedded shale. Sampled from shale.
SA-26	Roadcut on east side of Highway #180, approximately 2 km north of the intersection of Highways #180 and #185, north of Acayucan, Veracruz. Sample from auger hole on top of roadcut near south end of cut, penetration 1 m.
SA-27	Roadcut on west side of Highway #180 across from SA-26. Taken near base of cut (=Stop #12, Viniegra *et al.,* 1956, p. 165).

Texistepec-Almagres Syncline

TAS-80	Excavation in roadcut on south side of Highway #180, 5.54 km east of Acayucan, Veracruz. Sample taken at extreme western end of cut. Rust-colored fine sand and silt (=Stop #1, Viniegra *et al.,* 1956, p. 166).
TAS-82	Excavation on north side of Highway #180, at abandoned brickworks 9.25 km east of Acayucan. A brownish clayey silt (collected by Drs. E. H. and H. E. Vokes [Tulane Univ., New Orleans, LA]).

TULANE UNIVERSITY LOCALITIES

TU 1083 = my locality SD-4
TU 1139 = my locality SD-6
TU 1140 = my locality SD-18
TU 1151 = my locality PD-62
TU 1153 = my locality PD-33

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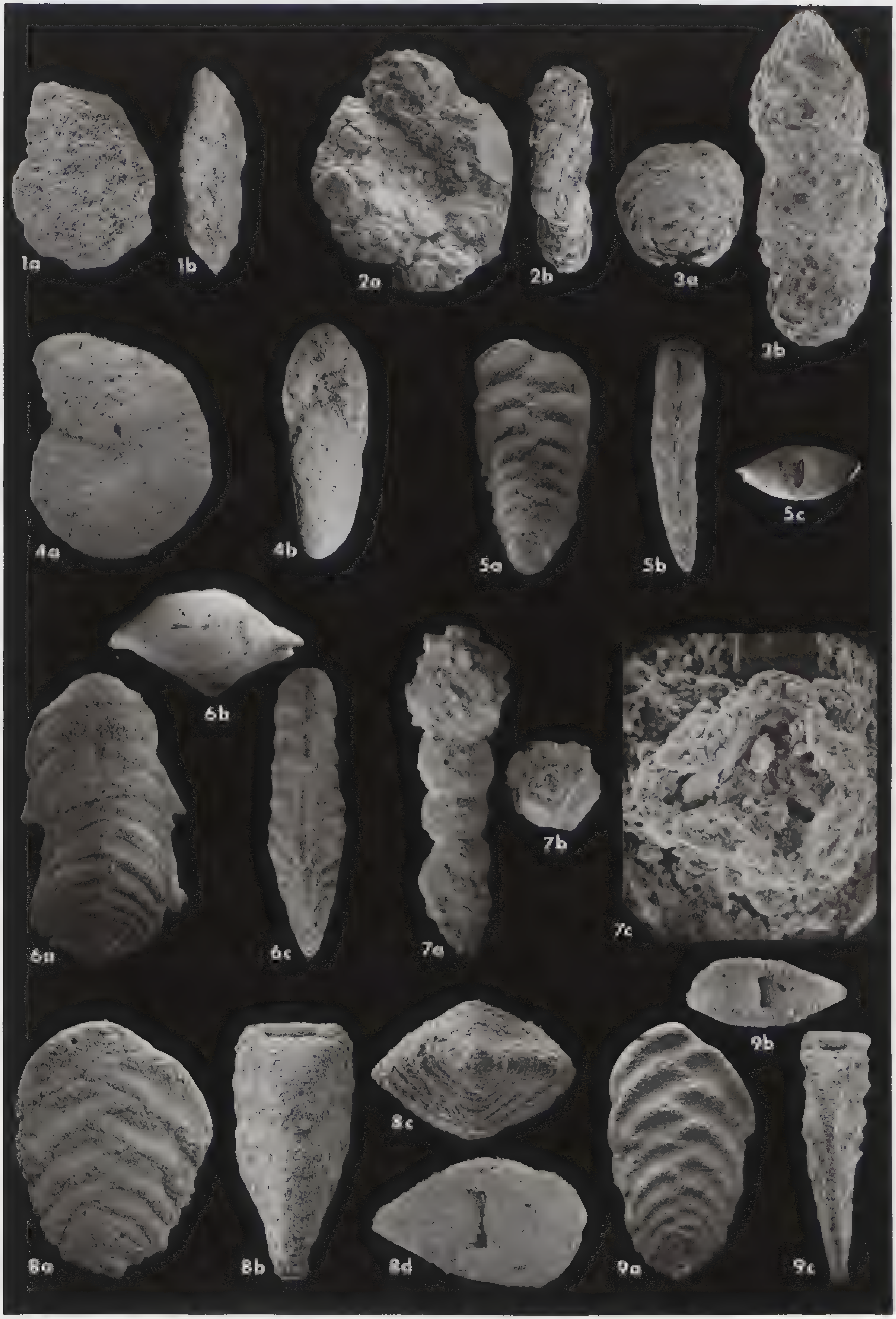
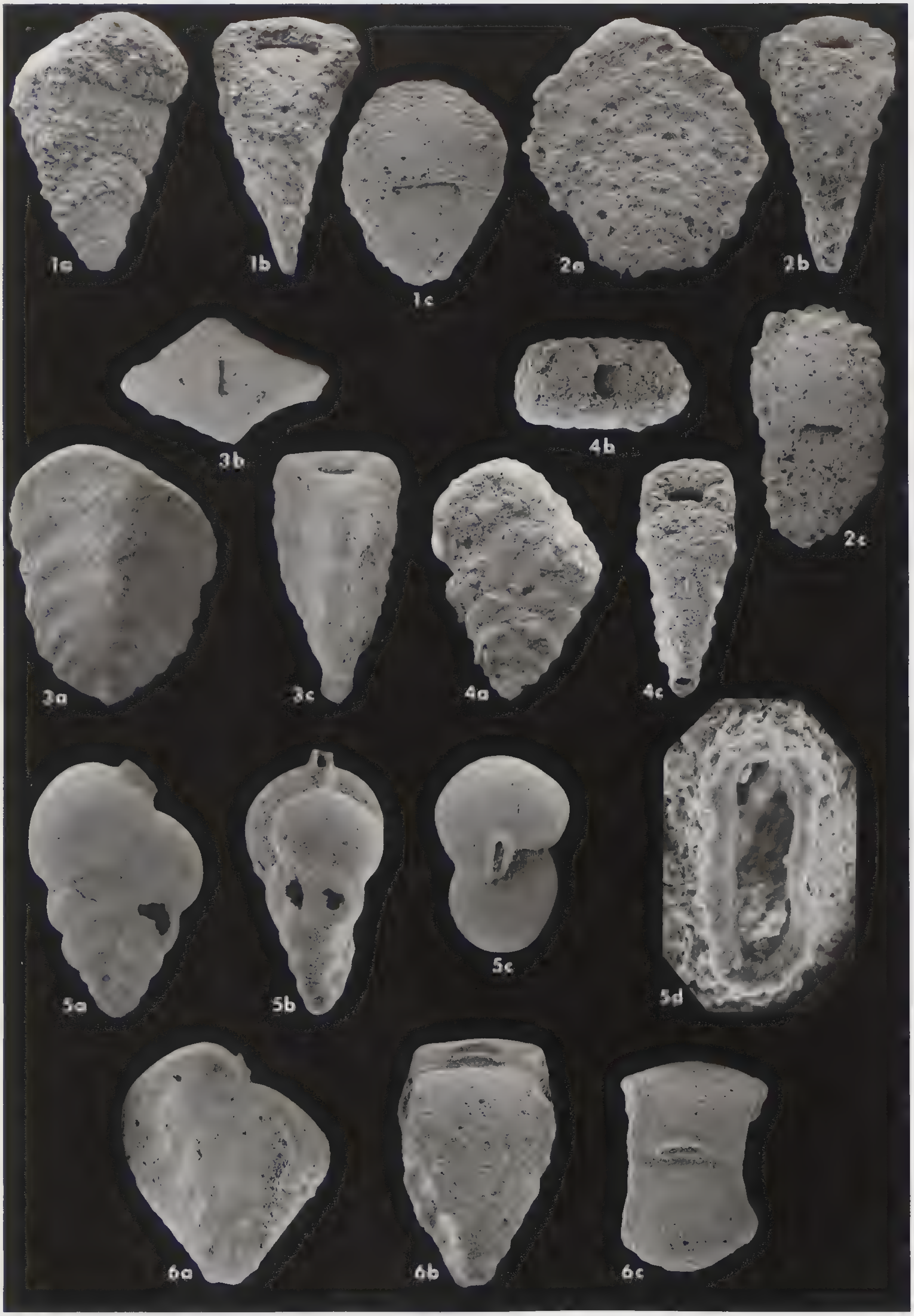
EXPLANATION OF PLATE 1

Figure .... Page

1. ***Haplophragmoides*** species A 27
   Locality PD-45.
   a. side view, ×44; b. edge view, ×42.
2. ***Haplophragmoides*** species B 28
   Locality PD-70.
   a. side view, ×38; b. edge view, ×35.
3. ***Reophax acosta*** Bermudez 27
   Locality PD-43.
   a. apertural view, ×25; b. side view, ×27.
4. ***Cyclammina cancellata*** Brady 28
   Locality PD-38.
   a. side view, ×25; b. edge view, ×25.
5. ***Spiroplectammina mississippiensis*** (Cushman) 28
   Locality SD-12.
   a. side view, ×24; b. edge view, ×22; c. apertural view, ×24.
6. ***Vulvulina miocenica*** Cushman 28
   Locality SD-12.
   a. side view, ×22; b. apertural view, ×26; c. edge view, ×22.
7. ***Bigenerina irregularis*** Phleger and Parker 29
   Locality PD-64.
   a. side view, ×64; b. apertural view, ×58; c. enlargement of aperture, ×445.
8. ***Textularia*** species A 29
   Locality PD-45.
   a. side view, ×58; b. edge view, ×64; c. basal view, ×65; d. apertural view, ×64.
9. ***Textularia bermudezi*** Cushman and Todd 29
   Locality PD-49.
   a. side view, ×38; b. apertural view, ×40; c. edge view, ×38.

PLATE 1

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Explanation of Plate 2

Figure | Page

1. ***Textularia calva*** Lalicker 30
   Locality PD-52.
   a. side view, ×38; b. edge view, ×40; c. apertural view, ×44.
2. ***Textularia lythostrota*** (Schwager) 30
   Locality SD-15.
   a. side view, ×62; b. edge view, ×62; c. apertural view, ×62.
3. ***Textularia mexicana*** Cushman 30
   Locality SD-12.
   a. side view, ×58; b. apertural view, ×56; c. edge view, ×60.
4. ***Textularia sica*** Lalicker and Bermudez 30
   Locality SD-29.
   a. side view, ×76; b. apertural view, ×72; c. edge view, ×76.
5. ***Siphotextularia affinis*** (Fornasini) 31
   Locality PD-63.
   a. side view, ×90; b. edge view, ×100; c. apertural view, ×98; d. enlargement of aperture, ×600.
6. ***Siphotextularia concava*** (Karrer) 31
   Locality PD-81.
   a. side view, ×88; b. edge view, ×90; c. apertural view, ×85.

EXPLANATION OF PLATE 3

Figure Page

1. ***Siphotextularia curta*** (Cushman) 31
Locality PD-68.
a. edge view, ×112; b. apertural view, ×105; c. side view, ×106.

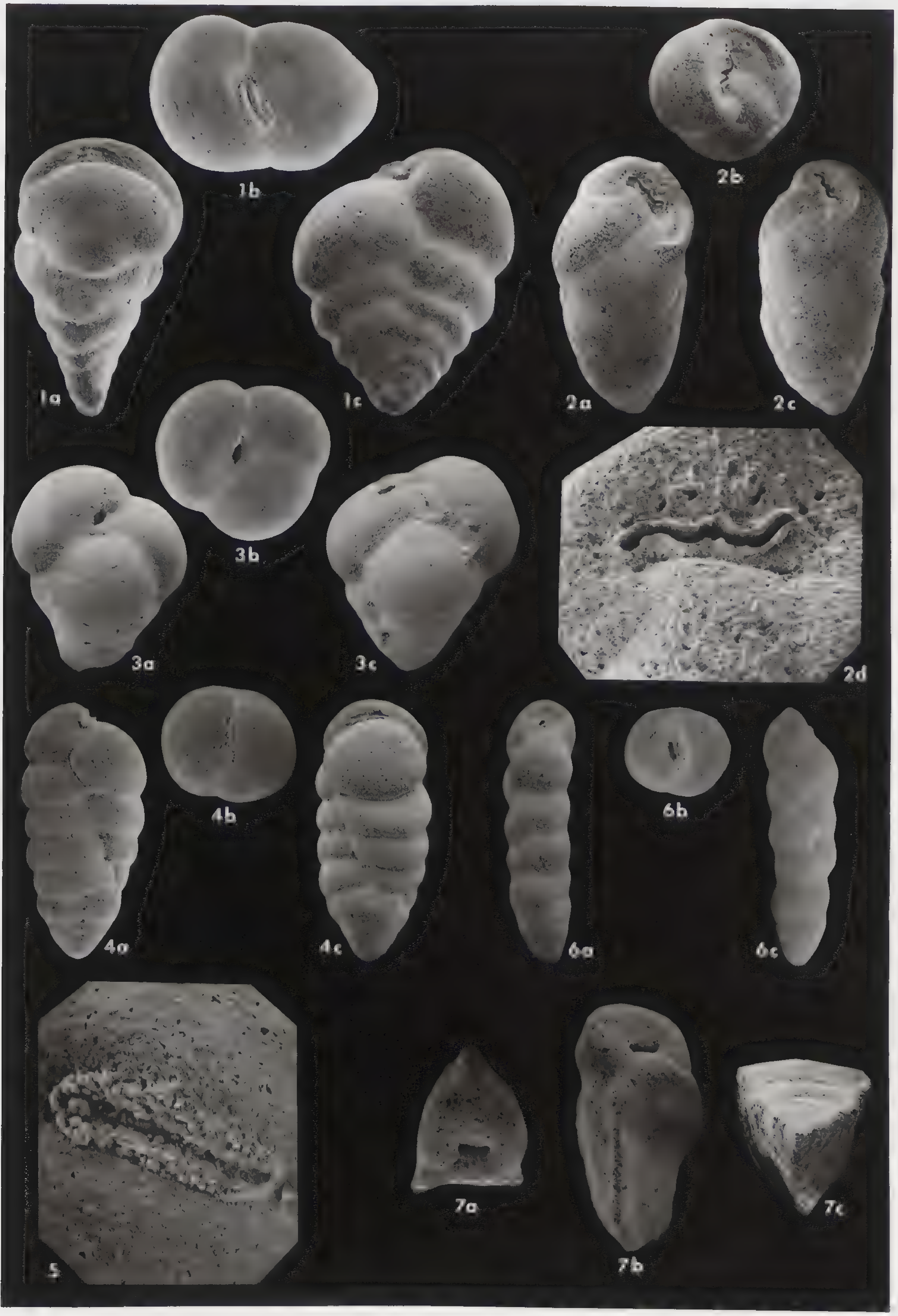
2. ***Alvarezina sinuata*** Akers and Dorman 32
Locality SD-12.
a. side view, ×25; b. apertural view, ×26; c. side view, ×25; d. enlargement of aperture, ×103.

3. ***Eggerella bradyi*** (Cushman) 32
Locality SD-4.
a. side view, ×108; b. apertural view, ×105; c. view of opposite side, ×125.

4–5. ***Karreriella bradyi*** (Cushman) 32
Locality PD-70.
4. a. side view, ×68; b. apertural view, ×72; c. edge view, ×68.
5. Enlargement of aperture, ×310.

6. ***Karreriella subcylindrica caribaea*** Acosta 32
Locality PD-70.
a. edge view, ×28; b. apertural view, ×38; c. side view, ×28.

7. ***Gaudryina atlantica*** (Bailey) 33
Locality SD-12.
a. apertural view, ×22; b. side view, ×22; c. basal view, ×22.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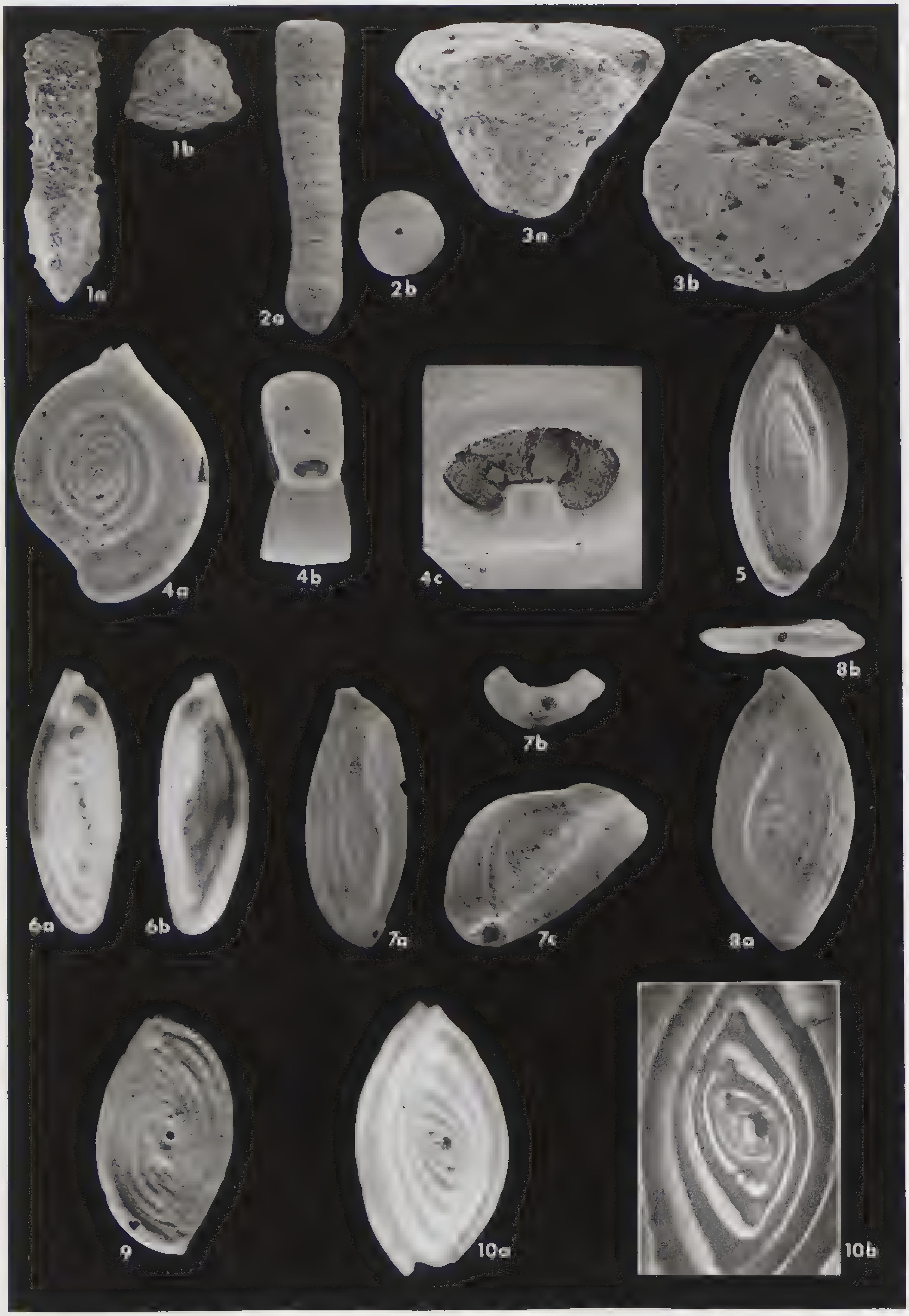
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EXPLANATION OF PLATE 4

Figure / Page

1. ***Clavulina mexicana*** Cushman 33
Locality SD-4.
a. side view, ×36; b. basal view, ×48.

2. ***Martinottiella communis*** (d'Orbigny) 33
Locality PD-70.
a. side view, ×40; b. apertural view, ×50.

3. ***Textulariella barrettii*** (Jones and Parker) 34
Locality SD-4.
a. side view, ×68; b. apertural view, ×62.

4. ***Spiroloculina alveata*** Cushman and Todd 34
Locality SD-12.
a. side view, ×58; b. apertural view, ×60; c. enlargement of aperture, ×300.

5–7. ***Spiroloculina? disparilis*** Terquem 34
Locality PD-81.
5. Side view, concave side, ×95.
Locality PD-40.
6. a. side view of convex side, reflected light, ×86; b. side view of concave side, reflected light, ×86.
Locality PD-81.
7. a. side view of concave side, ×100; b. apertural view, ×115; c. oblique view, ×152.

8–10. ***Ophthalmidium*** species A 35
Locality PD-70.
8. a. side view, ×92; b. apertural view, ×105.
9. Side view, ×75.
Locality PD-38.
10. a. side view, reflected light, ×116; b. enlargement of initial chambers, transmitted light, ×230.

Explanation of Plate 5

Figure Page

1. ***Pyrgo murrhina*** (Schwager) 35
   Locality PD-81.
   a. side view, ×62; b. apertural view, ×65; c. edge view, ×65.
2. ***Pyrgo phlegeri*** Andersen 35
   Locality PD-66.
   a. side view, ×72; b. apertural view, ×75; c. edge view, ×76.
3. ***Sigmoilinita distorta*** (Phleger and Parker) 35
   Locality SD-4.
   a. side view, ×110; b. apertural view, ×108; c. edge view, ×105.
4. ***Sigmoilinita elliptica*** (Galloway and Wissler) 36
   Locality PD-68.
   a. side view, ×76; b. apertural view, ×88; c. edge view, ×80; d. enlargement of aperture, ×900.
5. ***Sigmoilinita tenuis*** (Czjzek) 36
   Locality SD-12.
   a. side view, ×72; b. apertural view, ×76; c. view of opposite side, ×72; d. edge view, ×85.
6. ***Sigmoilopsis schlumbergeri*** (Silvestri) 36
   Locality SD-4.
   a. enlargement of aperture, ×310; b. side view, ×46; c. apertural view, ×48.

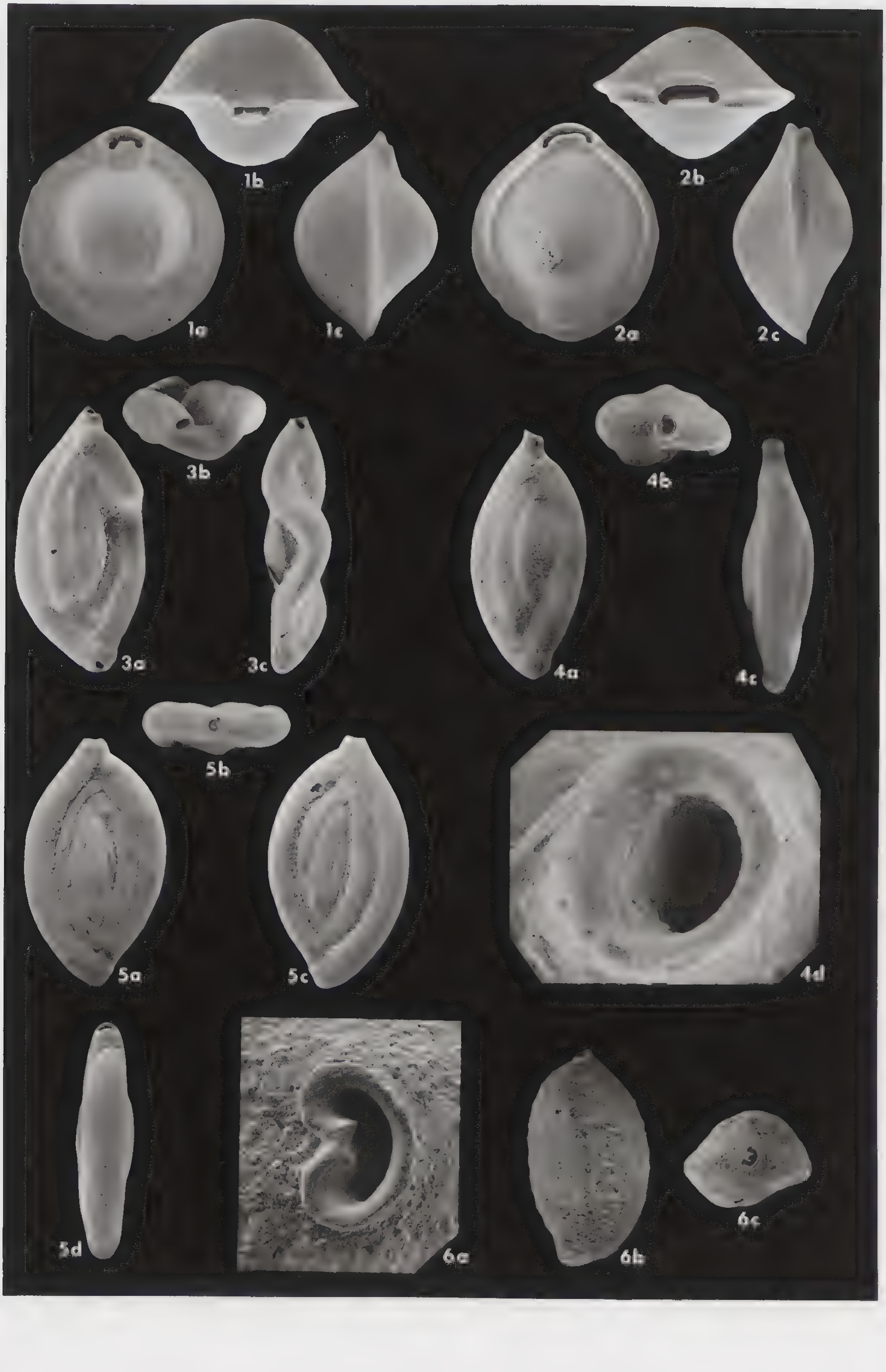
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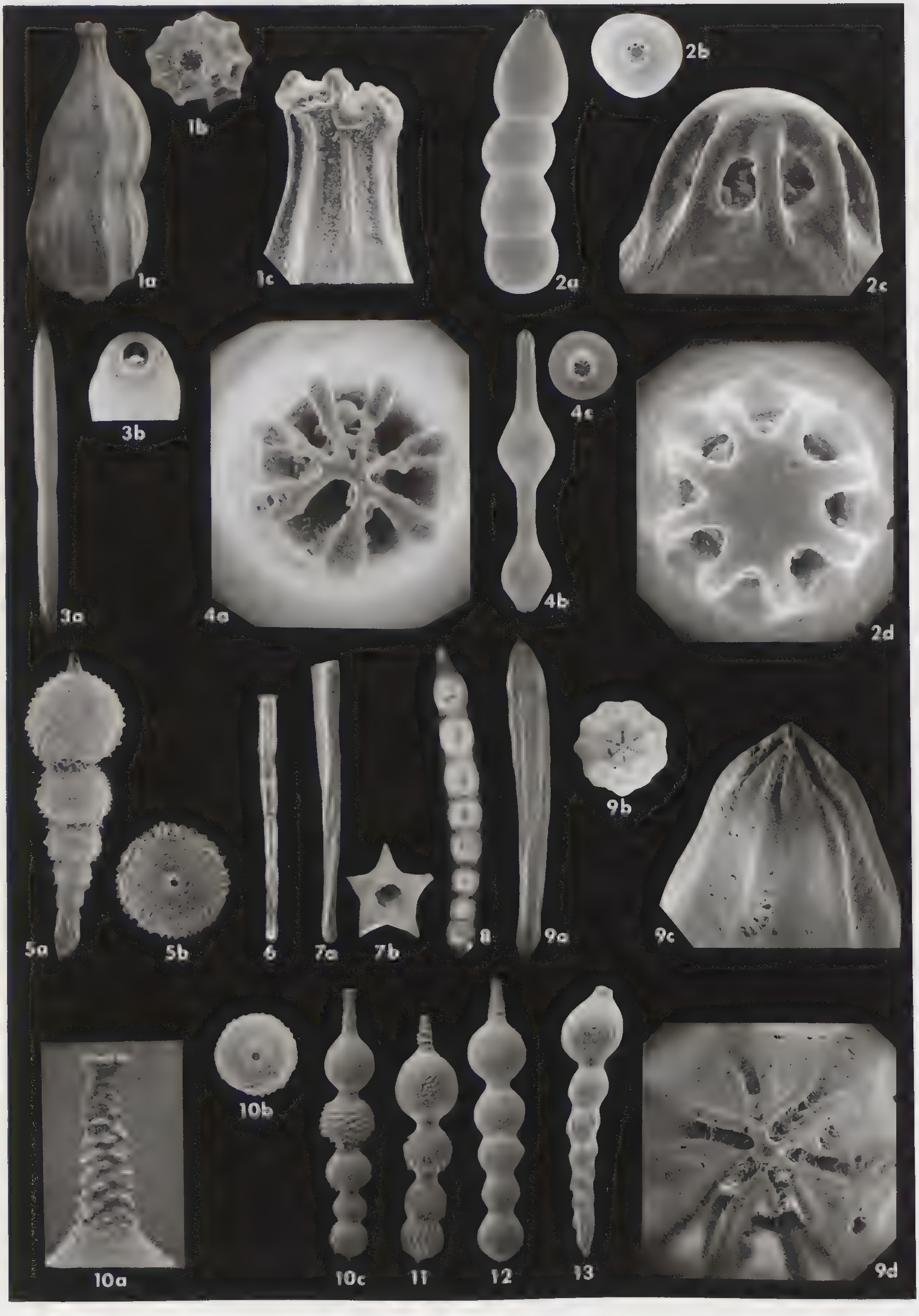
PLATE 6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Explanation of Plate 6

Figure Page

1. ***Nodosaria catesbyi*** d'Orbigny 42
Locality SD-4.
a. side view, ×70; b. apertural view, ×58; c. enlargement of neck and aperture, ×314.

2. ***Nodosaria glandulinoides*** Neugeboren 42
Locality PD-38.
a. side view, ×50; b. apertural view, ×54; c. enlargement of aperture, side view, ×524; d. enlargement of aperture, top view, ×488.

3. ***Nodosaria longiscata*** d'Orbigny 43
Locality PD-35.
a. side view, ×34; b. apertural view, ×130.

4. ***Nodosaria pyrula*** d'Orbigny 43
Locality PD-38.
a. enlargement of aperture, top view, ×624; b. side view, ×52; c. apertural view, ×64.

5. ***Nodosaria*** cf. ***N. subtertenuata*** Schwager 43
Locality PD-58.
a. side view, ×86; b. apertural view, ×100.

6–7. ***Nodosaria tosta*** Schwager 44
Locality PD-37.
6. Side view, reflected light, ×28.
Locality PD-35.
7. a. side view, ×32; b. apertural view, ×115.

8–9. ***Nodosaria vertebralis*** (Batsch) 44
Locality SD-4.
8. Side view, reflected light, ×32.
Locality PD-52.
9. a. side view, ×22; b. apertural view, ×56; c. enlargement of aperture, side view, ×148; d. enlargement of aperture, top view, ×275.

10–13. ***Amphicoryna sublineata*** (Brady) 37
Locality PD-35.
10. a. enlargement of neck, side view, ×140; b. apertural view, ×54; c. side view, hispid form, ×34.
Locality SD-4.
11. Side view, hispid and costate form, ×32.
Locality PD-35.
12. Side view, weakly costate form, ×30.
Locality PD-52.
13. Side view, microspheric form, ×74.

EXPLANATION OF PLATE 7

Figure Page

1. ***Chrysalogonium spinastelliferum,*** new species 37
Locality PD-35.
Holotype (USNM 400649): a. side view, ×58; b. apertural view, ×72; c. enlargement of aperture, ×625; d. enlargement of neck, ×230.

2. ***Chrysalogonium glabrum*** (Silvestri) 37
Locality PD-38.
a. side view, ×34; b. apertural view, ×54; c. enlargement of aperture and neck, side view, ×322; d. enlargement of aperture and neck, top view, ×560.

3–5. ***Dentalina communis*** d'Orbigny 39
Locality PD-58.
3. Side view, ×46.
Locality SD-4.
4. Side view, ×34.
Locality SD-4.
5. a. side view, ×55; b. apertural view, ×65; c. enlargement of aperture, ×522.

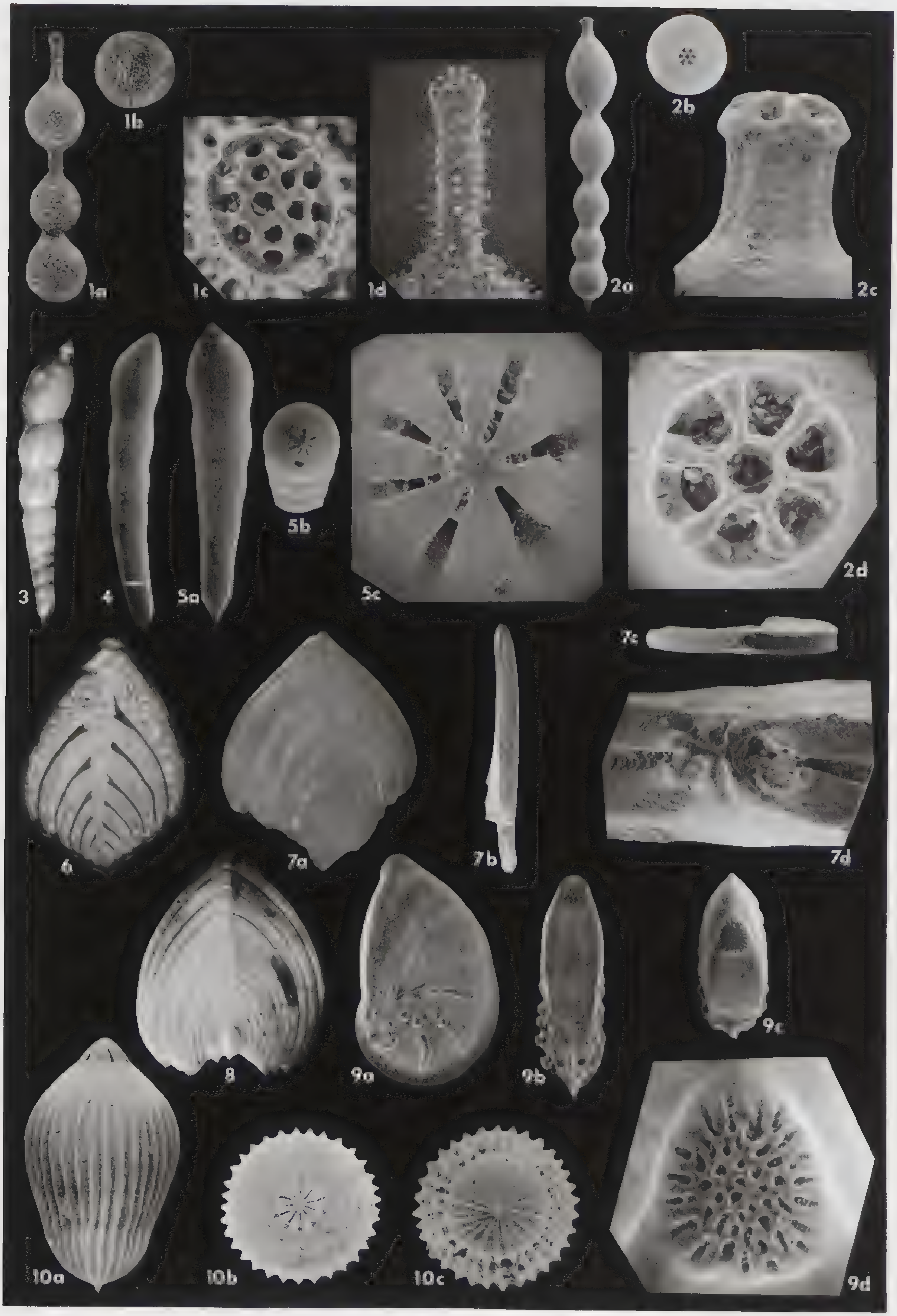
6–7. ***Lankesterina frondea*** (Cushman) 42
Locality SD-4.
6. Side view, reflected light, ×65.
7. a. side view, ×40; b. edge view, ×44; c. apertural view, ×44; d. enlargement of aperture, ×265.

8. ***Frondicularia cojimarensis*** Palmer 39
Locality PD-64.
Side view, ×9.

9. ***Cribrolenticulina akersi*** Haman 38
Locality SD-12.
a. side view, ×56; b. edge view, ×56; c. apertural view, ×58; d. enlargement of aperture, ×312.

10. ***Pseudonodosaria comatula*** (Cushman) 44
Locality PD-46.
a. side view, ×52; b. apertural view, ×54; c. basal view, ×58.

PLATE 7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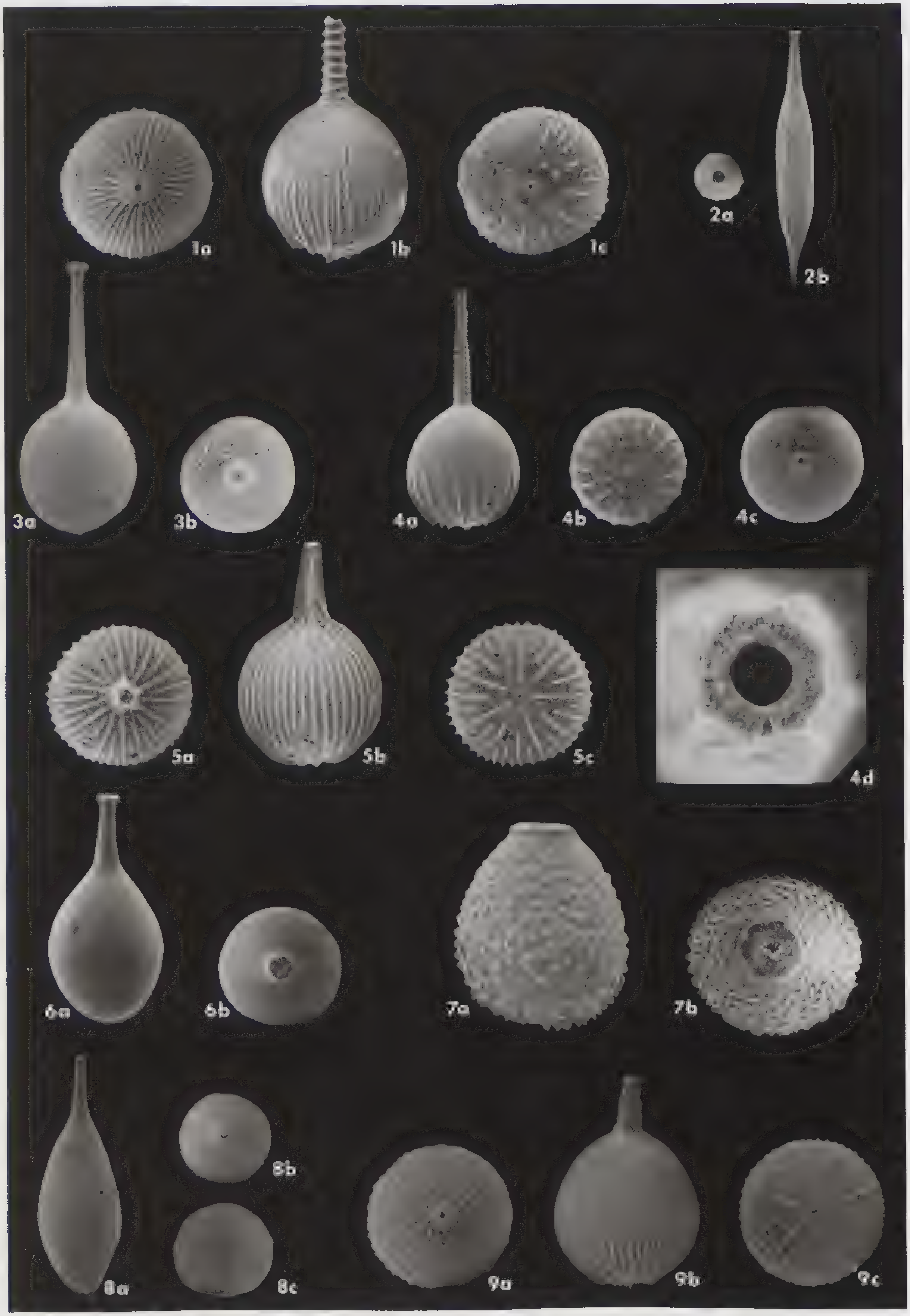
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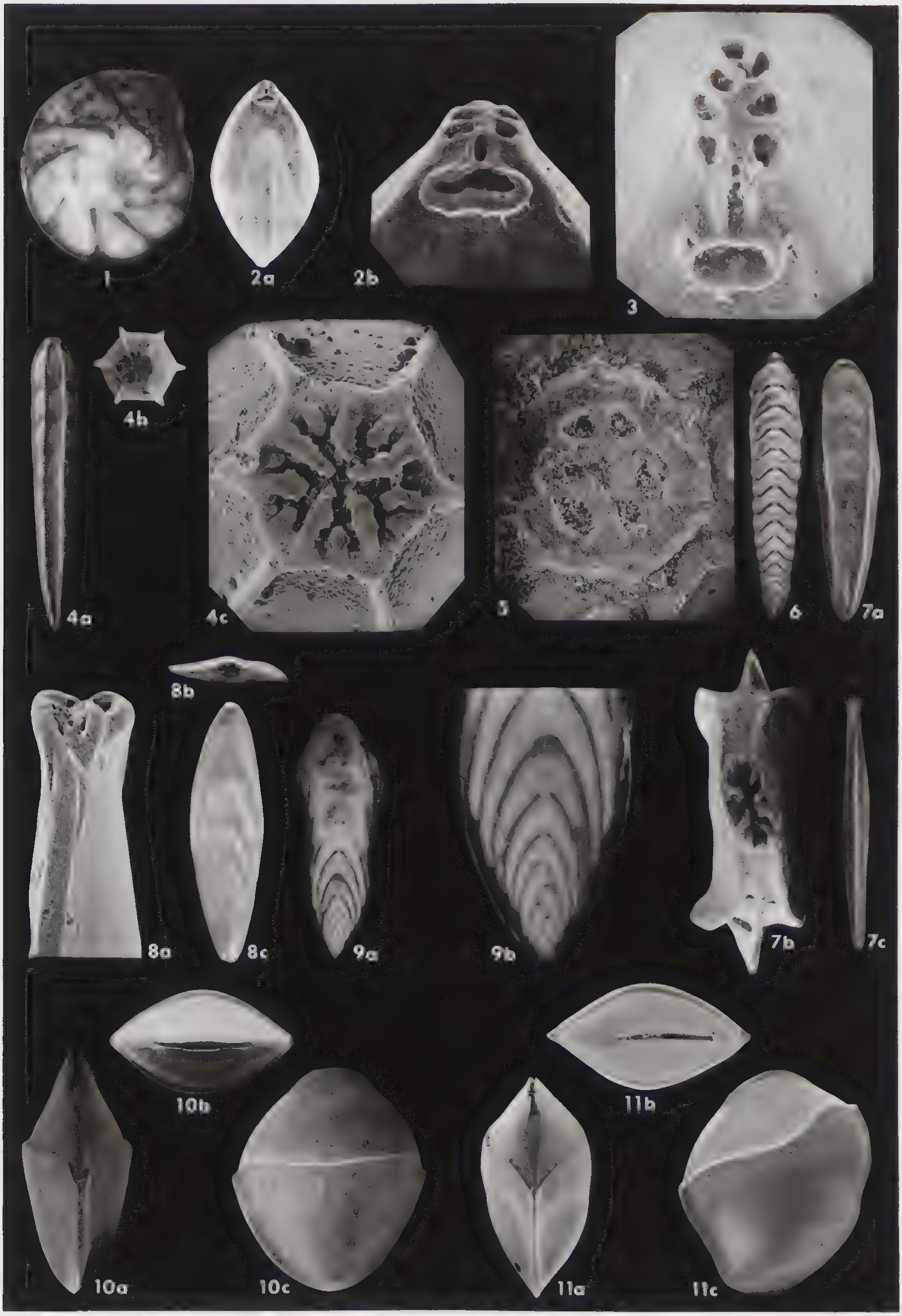
EXPLANATION OF PLATE 8

Figure — Page

1. ***Lagena striata basisenta*** Cushman and Stainforth 41
   Locality PD-35.
   a. apertural view, ×134; b. side view, ×134; c. basal view, ×134.
2. ***Lagena gracilis*** Williamson 39
   Locality SD-4.
   a. apertural view, ×70; b. side view, ×54.
3. ***Lagena hispidula*** Cushman 40
   Locality PD-40.
   a. side view, ×120; b. apertural view, ×122.
4. ***Lagena hoeglundi*** Todd and Brönnimann 40
   Locality PD-70.
   a. side view, ×58; b. basal view, ×58; c. apertural view, ×58; d. enlargement showing octagonal cross-section of neck, ×700.
5. ***Lagena laevicostata*** Cushman and Gray 40
   Locality SD-4.
   a. apertural view, ×122; b. side view, ×120; c. basal view, ×122.
6. ***Lagena laevis*** (Montagu) 40
   Locality PD-35.
   a. side view, ×100; b. apertural view, ×100.
7. ***Lagena rudis*** Reuss 41
   Locality SD-4.
   a. side view, ×98; b. apertural view, ×96.
8. ***Lagena setigera*** Millett 41
   Locality PD-45.
   a. side view, ×94; b. apertural view, ×94; c. basal view, ×114.
9. ***Lagena spirata*** Bandy 41
   Locality PD-45.
   a. apertural view, ×114; b. side view, ×114; c. basal view, ×114.

Explanation of Plate 9

Figure		Page
1–3.	***Cribrorobulina serpens*** (Seguenza)	38
	Locality PD-37.	
	1. Side view, reflected light, ×68.	
	Locality PD-52.	
	2. a. edge view, ×60; b. enlargement of aperture, edge view, ×280.	
	Locality PD-35.	
	3. Enlargement of aperture, top view, ×385.	
4–5.	***Amphimorphina stainforthi*** (Cushman and Renz)	45
	Locality PD-35.	
	4. a. side view, ×38; b. apertural view, ×74; c. enlargement of aperture, ×362.	
	Locality PD-68.	
	5. Cribrate aperture of penultimate chamber of dissected specimen, ×310.	
6–7.	***Plectofrondicularia floridana*** Cushman	45
	Locality PD-35.	
	6. Side view, reflected light, ×40.	
	Locality SD-4.	
	7. a. side view, ×28; b. enlargement of top view with radiate aperture, ×142; c. edge view, ×28.	
8–9.	***Plectofrondicularia advena*** (Cushman)	45
	Locality PD-38.	
	8. a. enlargement of aperture, edge view, ×525; b. apertural view, ×88; c. edge view, ×52.	
	Locality SD-4.	
	9. a. side view, reflected light, ×38; b. enlargement of fig. 9a showing biserial initial portion, ×100.	
10.	***Lingulina ponceana*** Galloway and Heminway	46
	Locality SD-12.	
	a. edge view, ×42; b. apertural view, ×42; c. side view, ×28.	
11.	***Lingulinopsis*** cf. ***L. cubensis*** (Cushman and Bermudez)	46
	Locality SD-12.	
	a. edge view, ×28; b. apertural view, ×28; c. side view, ×28.	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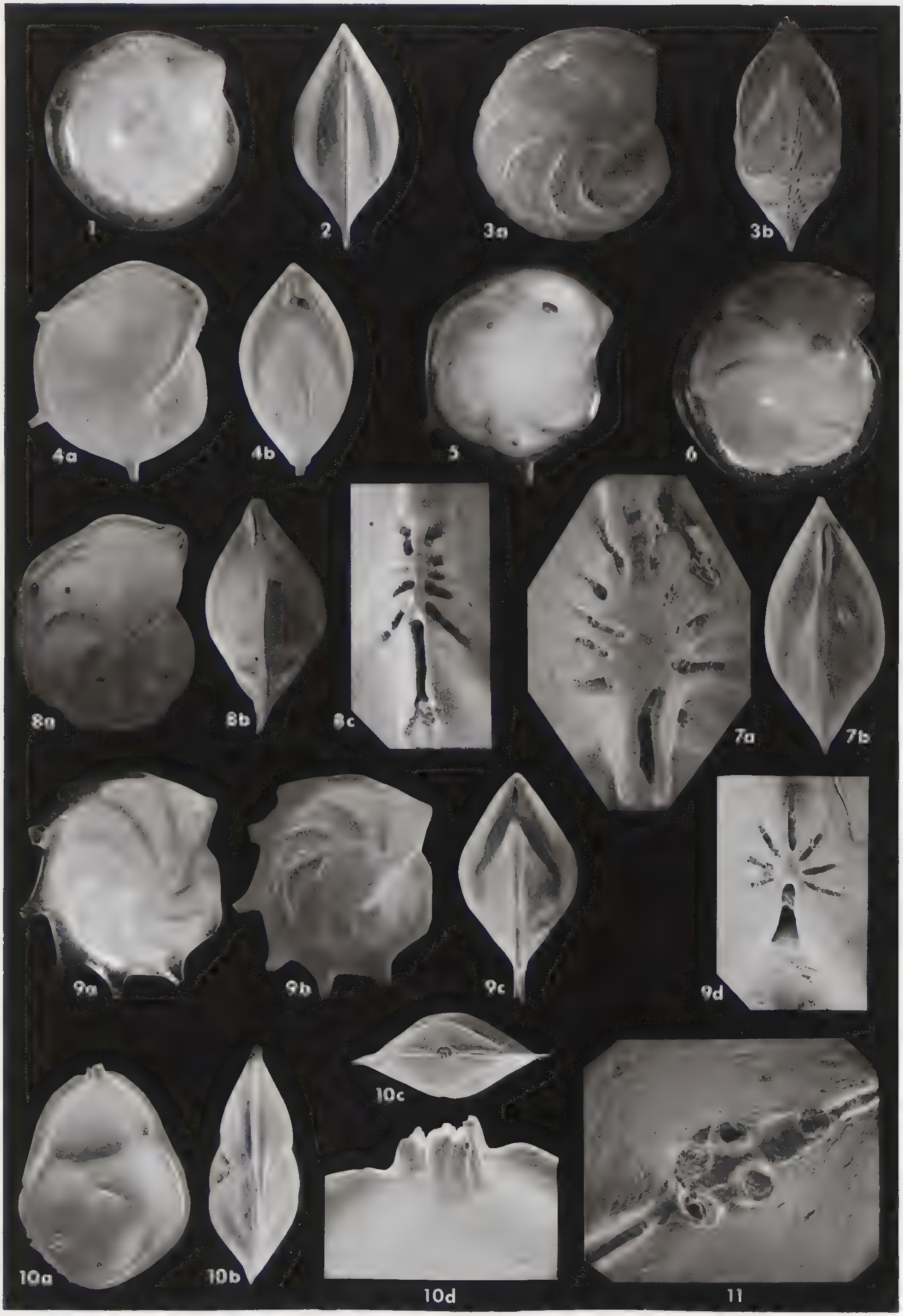
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EXPLANATION OF PLATE 10

Figure Page

1–2. ***Lenticulina atlantica*** (Barker) 46
Locality PD-35.
1. Side view, reflected light, ×88.
2. Edge view, ×74.

3. ***Lenticulina bowdenensis*** (Cushman) 47
Locality SD-12.
a. side view, ×22; b. edge view, ×24.

4–5. ***Lenticulina calcar*** (Linnaeus) 47
Locality SD-4.
4. a. side view, ×62; b. edge view, ×62.
Locality SD-12.
5. Side view, reflected light, ×52.

6–7. ***Lenticulina cultrata*** (Montfort) 47
Locality PD-35.
6. Side view, reflected light, ×68.
7. a. enlargement of aperture, ×260; b. edge view, ×58.

8. ***Lenticulina*** cf. ***L. falcifer*** (Stache) 48
Locality SD-4.
a. side view, ×28; b. edge view, ×30; c. enlargement of aperture, ×118.

9. ***Lenticulina formosa*** (Cushman) 48
Locality PD-52.
a. side view, reflected light, ×32; b. side view, ×28; c. edge view, ×30; d. enlargement of aperture, ×138.

10–11. ***Lenticulina peregrina*** (Schwager) 48
Locality PD-35.
10. a. side view, ×62; b. edge view, ×65; c. apertural view, ×62; d. enlargement of tubular aperture, ×300.
11. Top view of tubular aperture, ×525.

EXPLANATION OF PLATE 11

Figure Page

1. ***Lenticulina peregrina*** (Schwager) 48
Locality PD-35.
a. side view, ×58; b. apertural view, ×58; c. edge view, ×60; d. enlargement of radiate aperture, ×300.

2. ***Palmula tenuistriata*** Bermudez 49
Locality SD-4.
a. side view, transmitted light, ×22; b. side view, reflected light, ×22.

3–4. ***Saracenaria italica*** Defrance 49
Locality PD-56.
3. a. side view, ×26; b. apertural view, ×28; c. ventral view, ×26.
Locality PD-35.
4. Side view, reflected light, ×50.

5–6. ***Saracenaria latifrons*** (Brady) 49
Locality PD-52.
5. a. side view, ×34; b. apertural view, ×40; c. ventral view, ×36.
Locality PD-35.
6. Side view, reflected light, ×38.

7. ***Saracenaria nuttalli*** Sansores and Flores-Covarrubias 50
Locality PD-63.
a. side view, ×54; b. apertural view, ×58; c. ventral view, ×54.

8. ***Saracenaria toddae*** Bermudez 50
Locality PD-64.
a. side view, ×42; b. apertural view, ×50; c. ventral view, ×42; d. enlargement of aperture, ×338.

PLATE 11

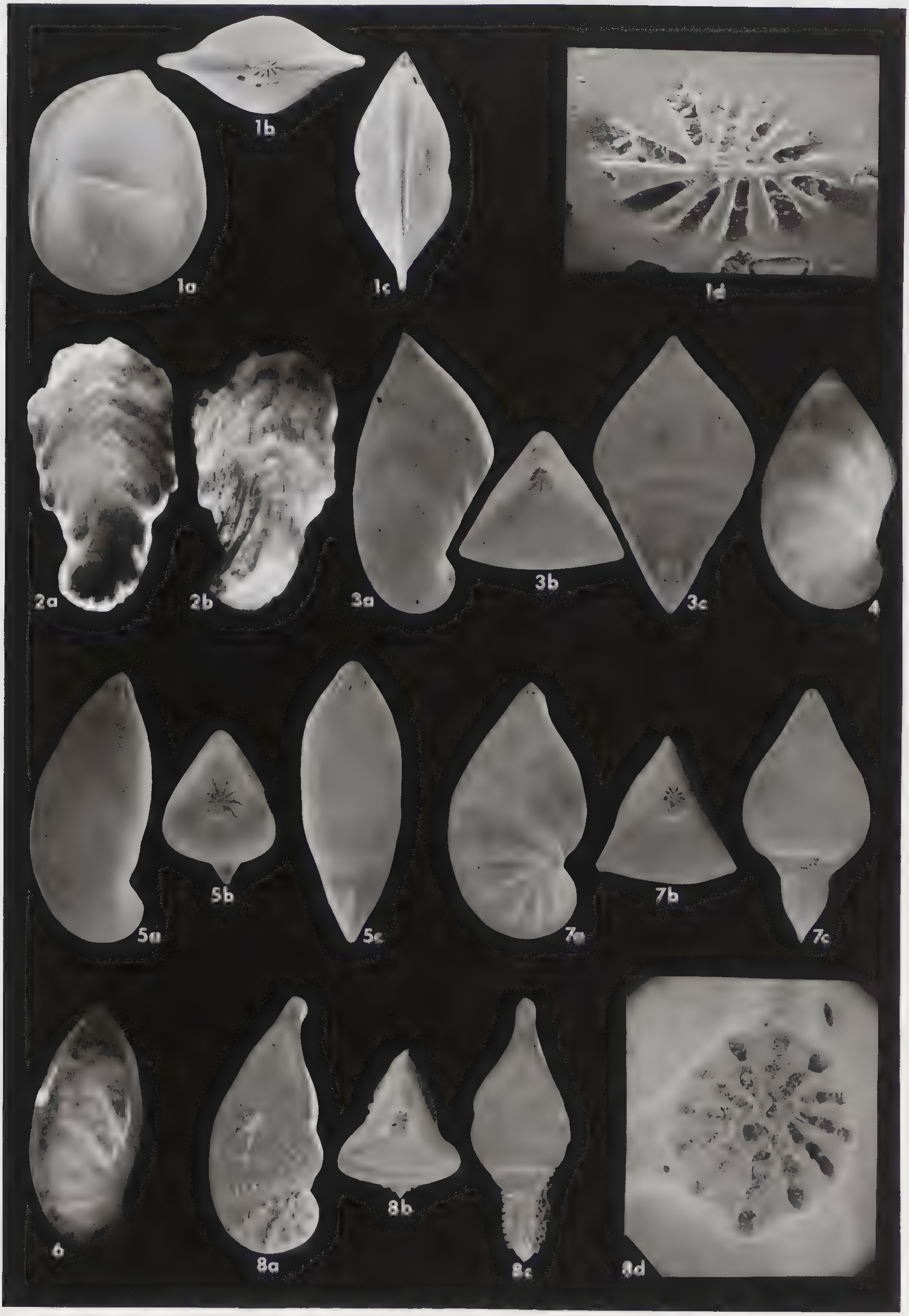
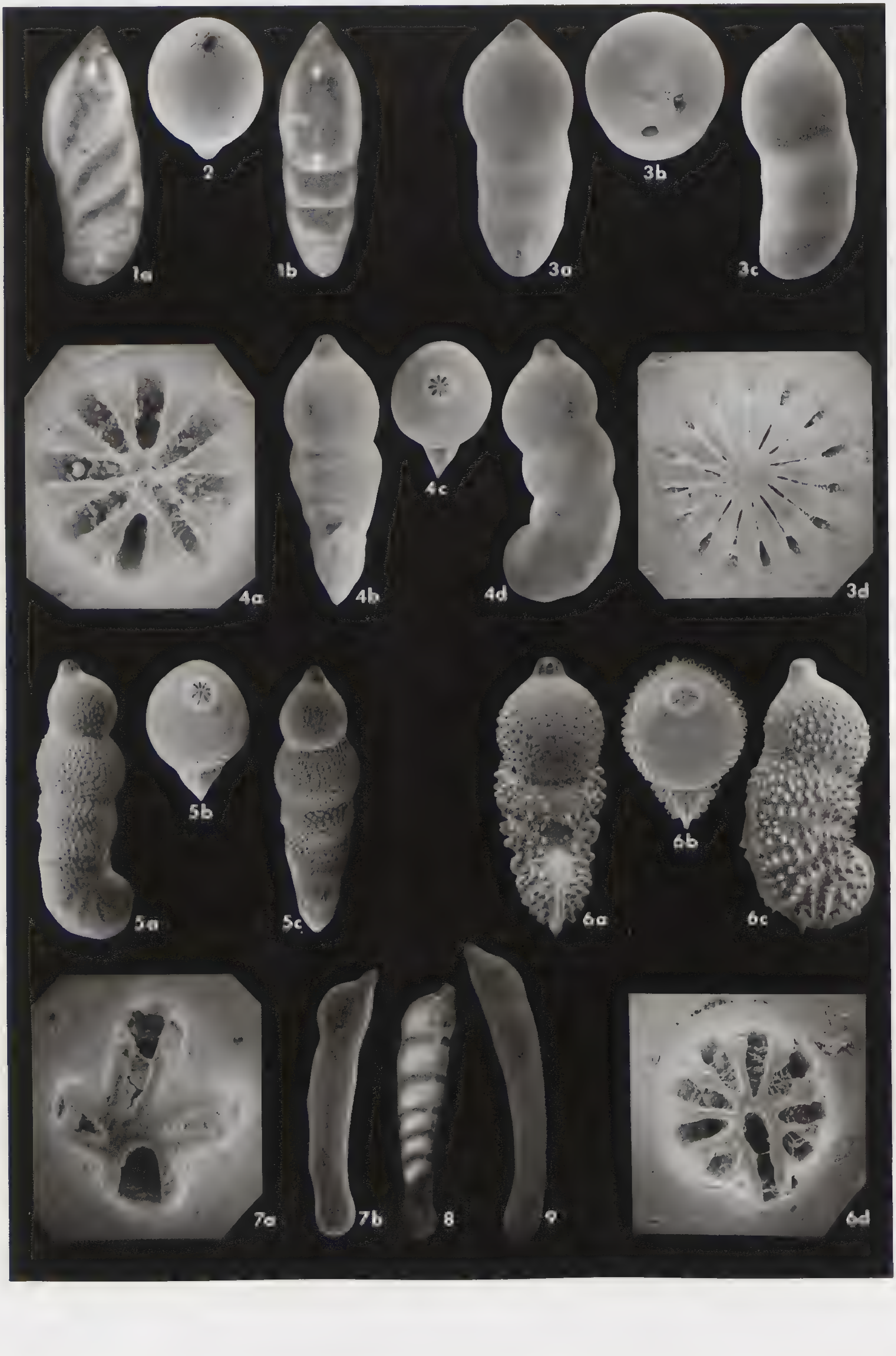


PLATE 12



Explanation of Plate 12

Figure — Page

1–2. ***Marginulina glabra*** d'Orbigny 50
Locality PD-81.
1. a. side view, reflected light, ×78; b. ventral view, reflected light, ×78.
2. Apertural view, ×100.

3. ***Marginulina obesa*** Cushman 51
Locality PD-35.
a. ventral view, ×64; b. top view, ×80; c. side view, ×64; d. enlargement of aperture, ×415.

4. ***Marginulinopsis goajiraensis*** Becker and Dusenbury 51
Locality PD-76.
a. enlargement of aperture, ×275; b. ventral view, ×32; c. apertural view, ×34; d. side view, ×32.

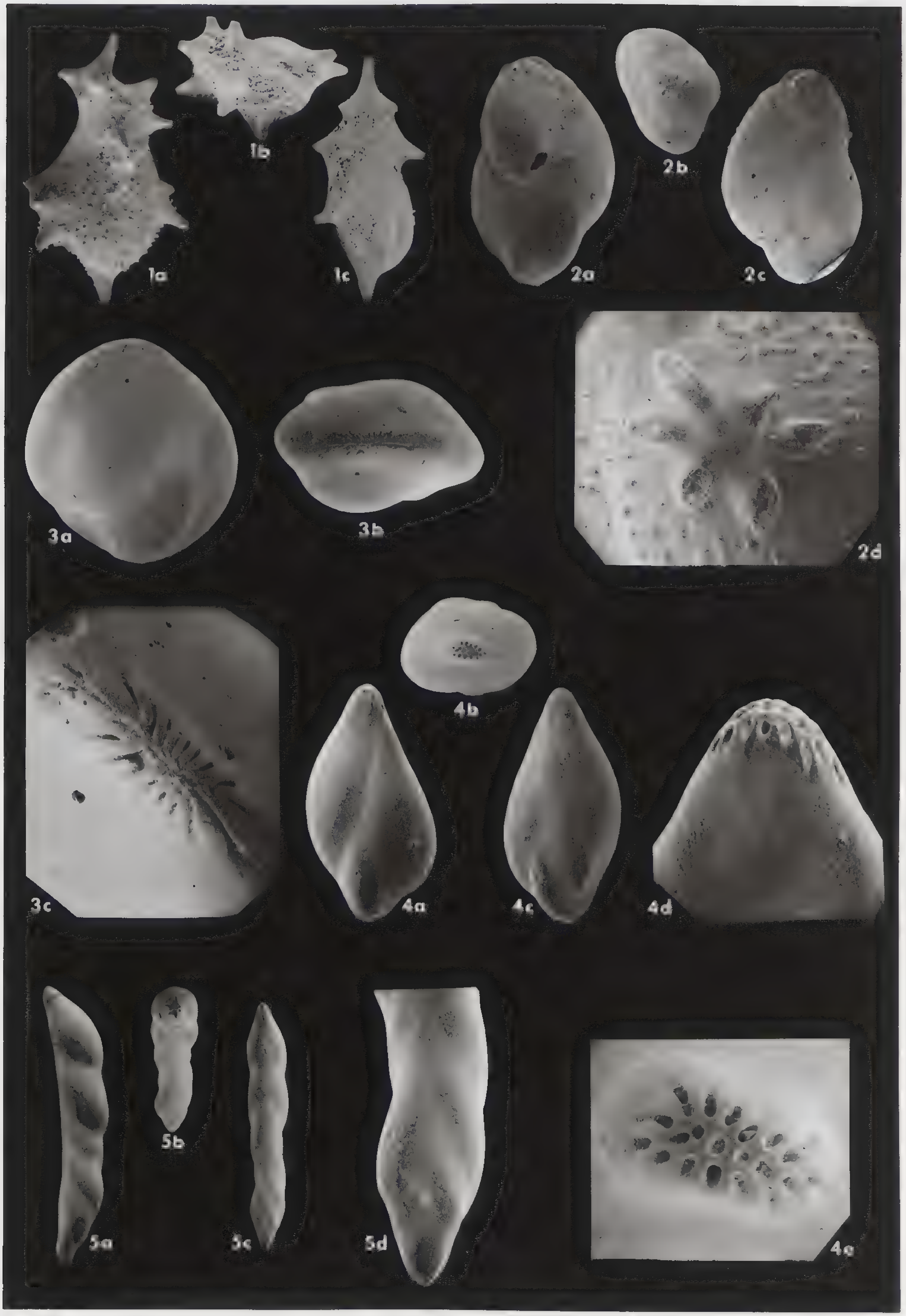
5. ***Marginulinopsis hispaniolana*** (Bermudez) 51
Locality SD-4.
a. side view, ×28; b. apertural view, ×30; c. ventral view, ×28.

6. ***Marginulinopsis nana*** (Costa) 52
Locality PD-40.
a. ventral view, ×42; b. apertural view, ×46; c. side view, ×40; d. enlargement of aperture, ×285.

7–9. ***Vaginulina alazanensis*** Nuttall 52
Locality SD-4.
7. a. enlargement of aperture, ×712; b. side view, ×52.
Locality PD-43.
8. Side view, reflected light, ×50.
Locality SD-4.
9. Side view, ×42.

EXPLANATION OF PLATE 13

Figure	Page
1. ***Globulina*** species Locality PD-45. a. side view, ×68; b. apertural view, ×70; c. edge view, ×68.	52
2. ***Vasiglobulina*** species Locality SD-12. a. side view, ×68; b. apertural view, ×62; c. opposite side, ×65; d. enlargement of tubular apertures, ×275.	53
3. ***Sigmomorphina*** species A Locality SD-4. a. side view, ×52; b. apertural view, ×54; c. enlargement of aperture, ×155.	53
4. ***Guttulina*** cf. ***G. sadoensis*** (Cushman and Ozawa) Locality SD-12. a. side view, ×63; b. apertural view, ×65; c. opposite side, ×55; d. enlargement of aperture, side view, ×322; e. enlargement of aperture, top view, ×233.	52
5. ***Paradentalina muraii*** (Uchio) Locality SD-4. a. side view, ×36; b. apertural view, ×38; c. ventral view, ×32; d. enlargement of biserial initial portion, ×98.	53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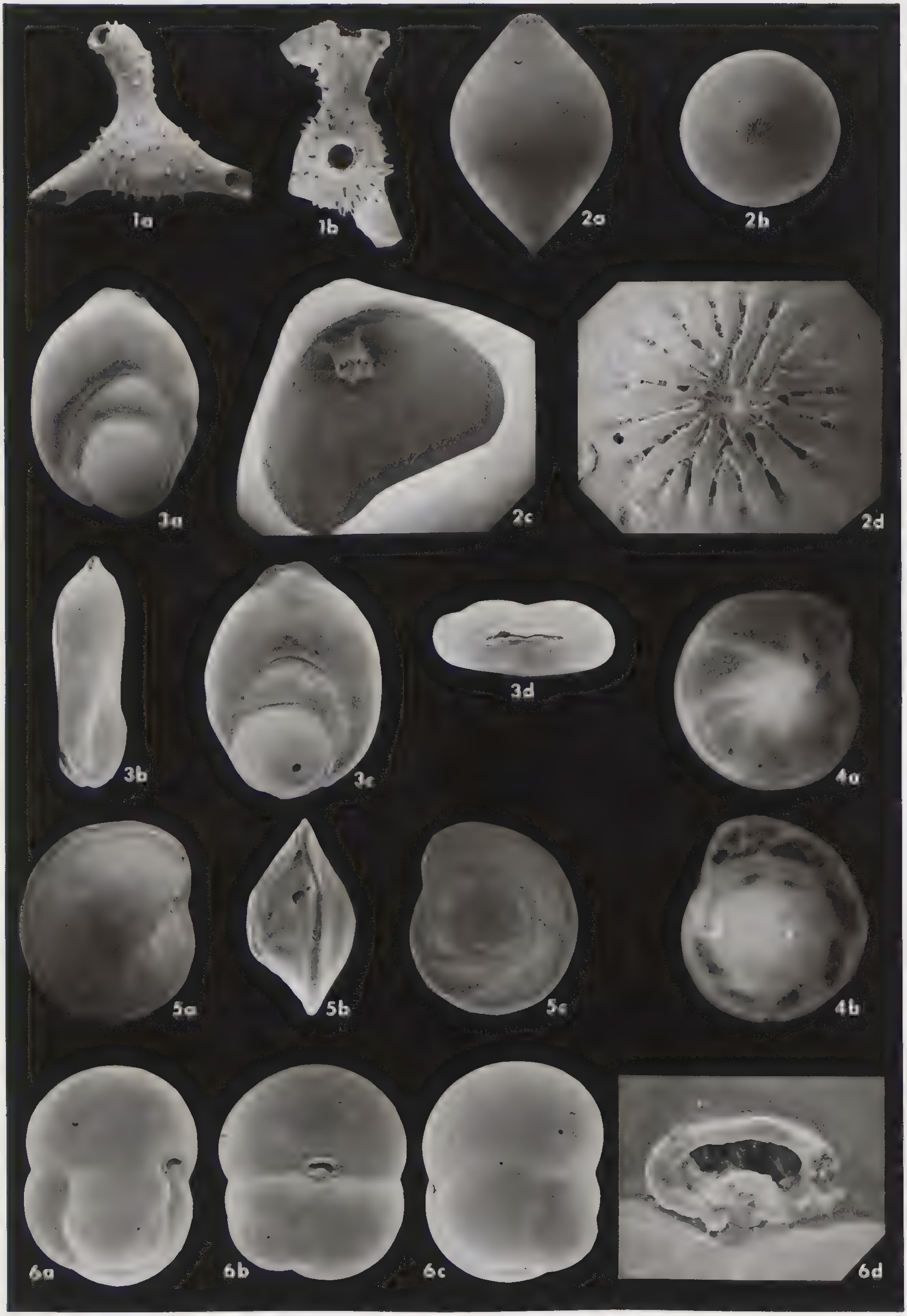
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EXPLANATION OF PLATE 14

Figure — Page

1. ***Ramulina globulifera*** Brady 54
Locality SD-4.
a. side view, ×64; b. edge view, ×78.

2. ***Glandulina laevigata*** d'Orbigny 54
Locality SD-4.
a. side view, ×65; b. apertural view, ×64; c. dissected chamber showing entosolenian tube, ×132; d. enlargement of aperture, ×338.

3. ***Entolingulina alazanensis*** (Nuttall) 54
Locality SD-9.
a. side view, ×60; b. edge view, ×60; c. opposite side, ×62; d. apertural view, ×68.

4–5. ***Hoeglundina elegans*** (d'Orbigny) 59
Locality SD-12.
4. a. umbilical view, reflected light, ×64; b. spiral view, reflected light, ×64.
5. a. umbilical view, ×54; b. edge view, with broken last chamber and lateromarginal aperture missing, ×48; c. spiral view, ×52.

6. ***Sphaeroidina bulloides*** d'Orbigny 59
Locality PD-81.
a. side view, ×114; b. ventral view, ×114; c. spiral view, ×120; d. enlargement of aperture, ×608.

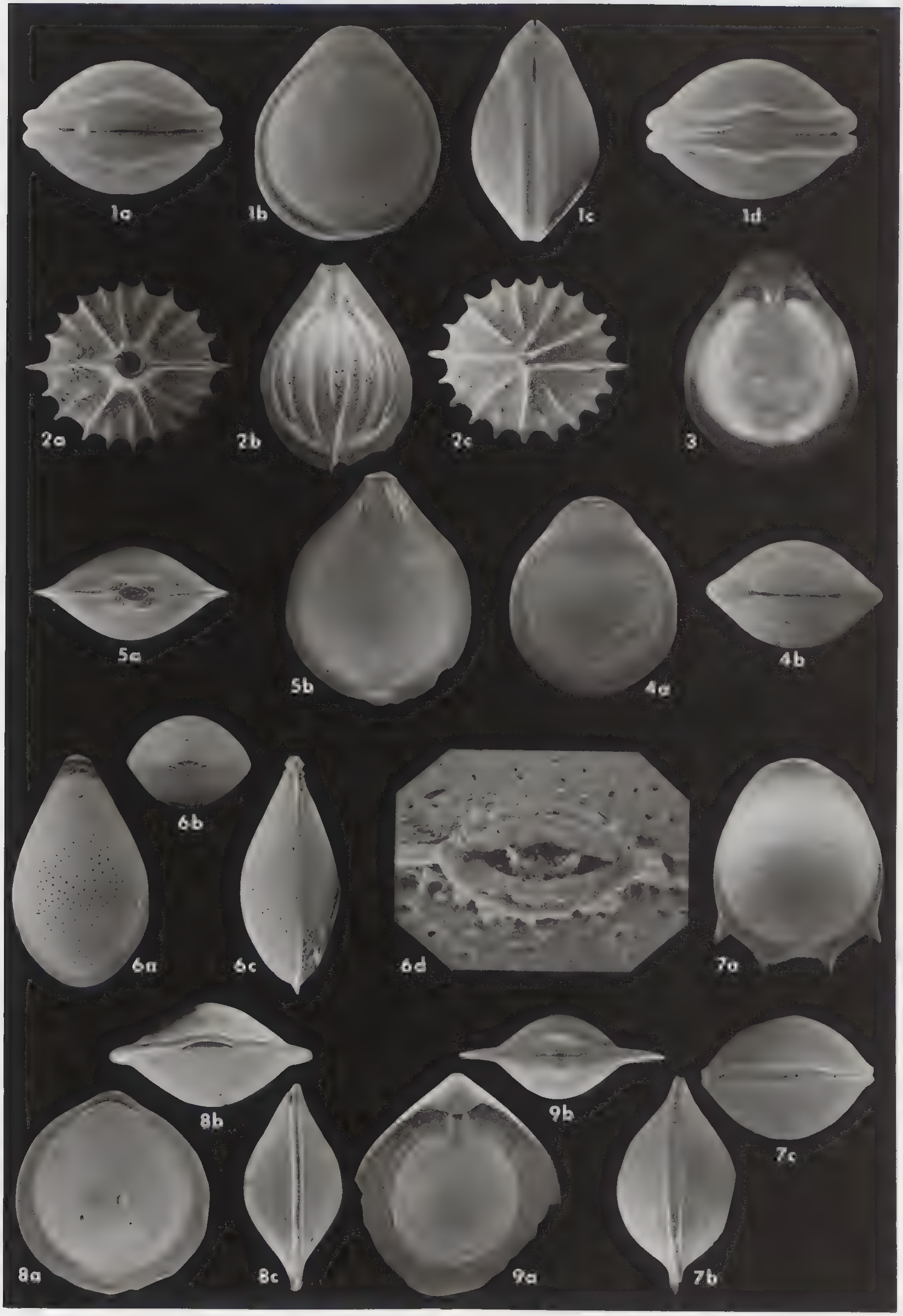
EXPLANATION OF PLATE 15

Figure Page

1. ***Fissurina bodjonegoroensis*** (Boomgaart) 55
   Locality PD-35.
   a. apertural view, ×94; b. side view, ×88; c. edge view, ×88; d. basal view, ×98.
2. ***Fissurina fistulosa*** (Matthes) 55
   Locality SD-4.
   a. apertural view, ×210; b. side view, ×158; c. basal view, ×210.

3–4. ***Fissurina lucida*** (Williamson) 55
   Locality PD-37.
   3. Side view, reflected light, ×130.
   Locality PD-35.
   4. a. side view, ×115; b. apertural view, ×115.

5. ***Fissurina marginata*** (Montagu) 55
   Locality PD-68.
   a. apertural view, ×102; b. side view, ×102.
6. ***Fissurina millettii*** Todd 56
   Locality PD-63.
   a. side view, ×145; b. apertural view, ×135; c. edge view, ×145; d. enlargement of aperture, ×950.
7. ***Fissurina neptuni*** (Buchner) 56
   Locality SD-4.
   a. side view, ×88; b. edge view, ×85; c. apertural view, ×88.
8. ***Parafissurina pseudomarginata*** (Buchner) 59
   Locality PD-52.
   a. side view, ×50; b. apertural view, ×54; c. edge view, ×50.
9. ***Fissurina schwageriana*** (Cushman) 56
   Locality PD-70.
   a. side view, ×62; b. apertural view, ×62.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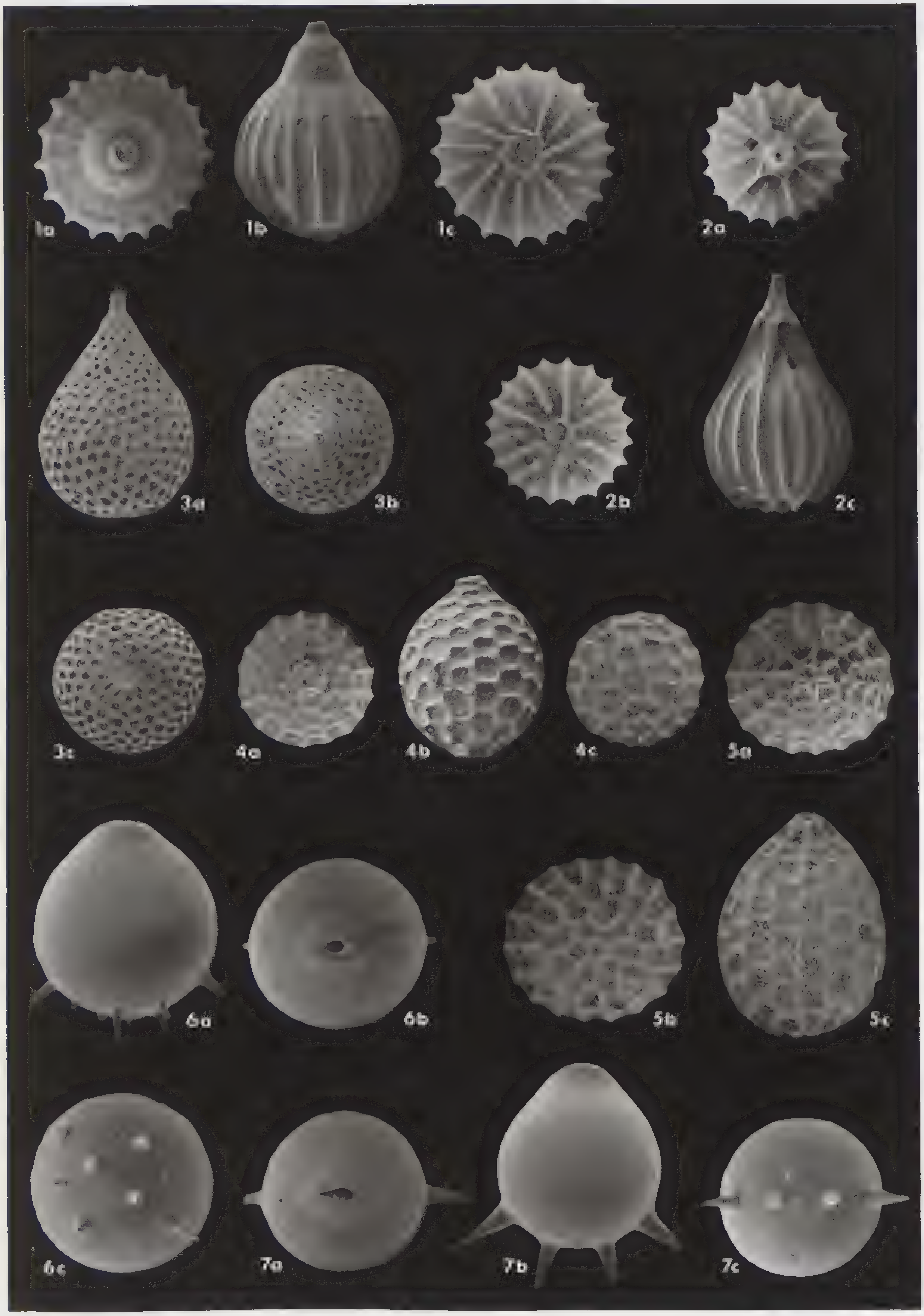


EXPLANATION OF PLATE 16

Figure		Page
1.	***Oolina sayulensis,*** new species Locality PD-45. Holotype (USNM 400651): a. apertural view, ×100; b. side view, ×92; c. basal view, ×105.	56
2.	***Oolina*** cf. ***O. alifera*** (Reuss) Locality PD-37. a. apertural view, ×108; b. basal view, ×108; c. side view, ×108.	57
3.	***Oolina cellularis*** (Silvestri) Locality SD-12. a. side view, ×96; b. apertural view, ×96; c. basal view, ×95.	57
4.	***Oolina hexagona*** (Williamson) Locality PD-56. a. apertural view, ×140; b. side view, ×148; c. basal view, ×140.	57
5.	***Oolina melo*** d'Orbigny Locality SD-4. a. apertural view, ×88; b. basal view, ×95; c. side view, ×95.	58
6.	***Oolina setosa*** (Earland) Locality PD-35. a. side view, ×100; b. apertural view, ×100; c. basal view, ×100.	58
7.	***Oolina staphyllearia*** (Schwager) Locality PD-35. a. apertural view, ×100; b. side view, ×100; c. basal view, ×100.	58

EXPLANATION OF PLATE 17

Figure Page

1. ***Bolivina imporcata*** Cushman and Renz 60
Locality SD-4.
a. side view, ×62; b. apertural view, ×60; c. edge view, ×58.

2–3. ***Bolivina scalprata miocenica*** Macfayden 60
Locality PD-43.
2. a. side view, ×88; b. apertural view, ×112; c. edge view, ×85.
Locality PD-68.
3. Side view, reflected light, ×78.

4–5. ***Brizalina albatrossi*** (Cushman) 61
Locality PD-68.
4. a. side view, ×90; b. apertural view, ×104; c. edge view, ×92.
5. Side view, reflected light, ×106.

6. ***Brizalina alata*** (Seguenza) 61
Locality PD-38.
a. side view, ×74; b. apertural view, ×92; c. edge view, ×80; d. enlargement of aperture, ×1000.

7. ***Brizalina barbata*** (Phleger and Parker) 61
Locality PD-43.
a. side view, ×82; b. apertural view, ×115; c. edge view, ×92.

8. ***Brizalina striatula spinata*** (Cushman) 62
Locality PD-64.
a. enlargement of aperture, ×912; b. side view, ×70; c. apertural view, ×125; d. edge view, ×70.

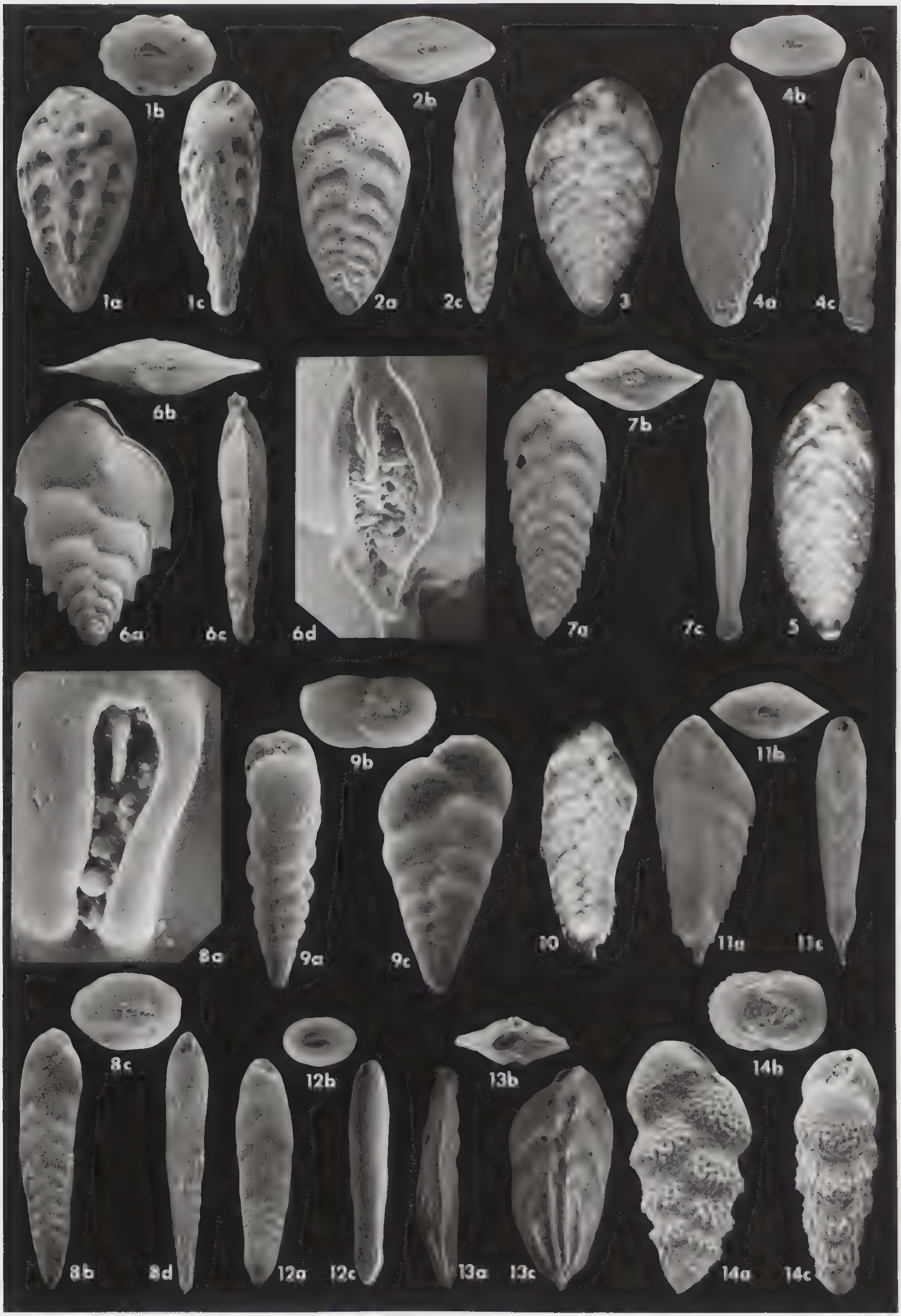
9. ***Brizalina inflata*** (Heron–Allen and Earland) 62
Locality PD-56.
a. edge view, ×138; b. apertural view, ×135; c. side view, ×140.

10–11. ***Brizalina*** cf. ***B. furcata*** (Cushman and Jarvis) 62
Locality PD-68.
10. Side view, reflected light, ×78.
11. a. side view, ×72; b. apertural view, ×72; c. edge view, ×74.

12. ***Brizalina striatula*** (Cushman) 62
Locality SD-4.
a. side view, ×54; b. apertural view, ×68; c. edge view, ×54.

13. ***Brizalina subaenariensis*** (Cushman) 63
Locality SD-4.
a. edge view, ×60; b. apertural view, ×64; c. side view, ×60.

14. ***Laterostomella subspinescens*** (Cushman) 63
Locality PD-68.
a. side view, ×170; b. apertural view, ×162; c. edge view, ×164.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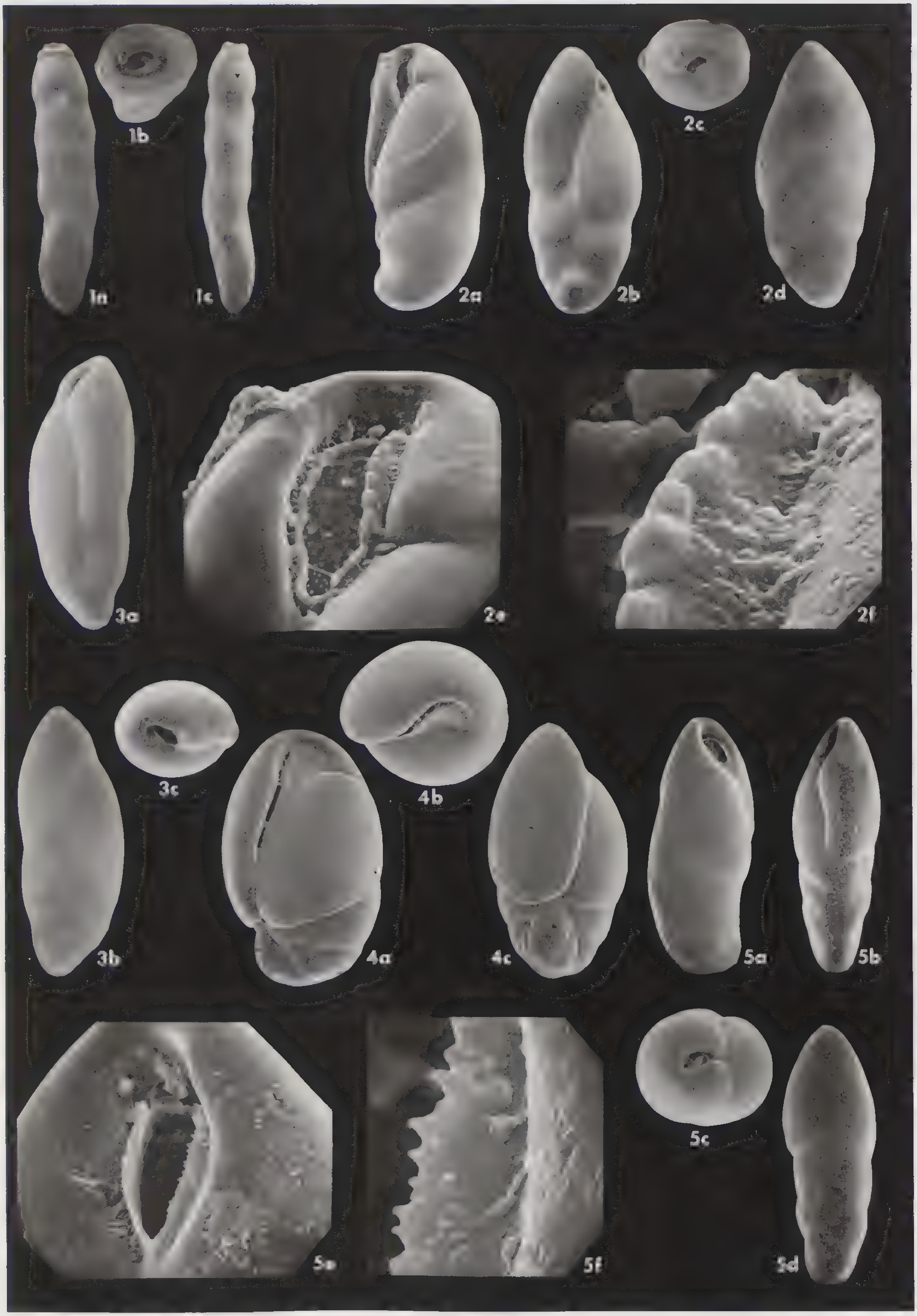
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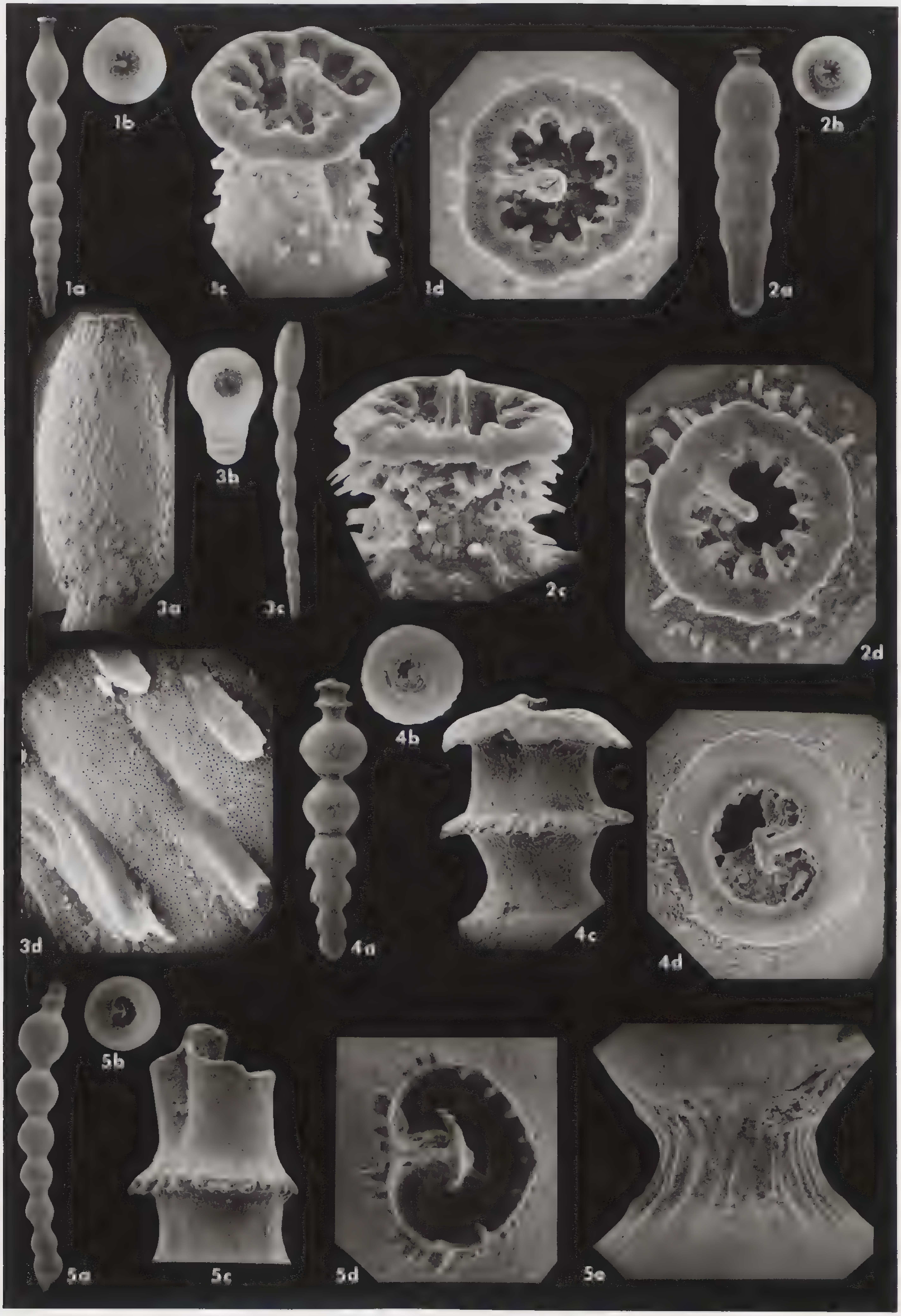
EXPLANATION OF PLATE 18

Figure — Page

1. ***Rectobolivina limbata costulata*** (Cushman) 63
   Locality SD-4.
   a. side view, ×54; b. apertural view, ×90; c. edge view, ×58.
2. ***Rutherfordoides erecta*** (Cushman and Renz) 89
   Locality PD-38.
   a. side view, ×102; b. ventral view, ×102; c. apertural view, ×88; d. dorsal view, ×122; e. enlargement of aperture, ×538; f. enlargement of toothplate, ×2600.
3. ***Rutherfordoides mexicana*** (Cushman) 89
   Locality PD-70.
   a. ventral view, ×85; b. dorsal view, ×83; c. apertural view, ×120.
4. ***Lernella seranensis*** (Germeraad) 88
   Locality PD-40.
   a. side view, ×108; b. apertural view, ×112; c. ventral view, ×108.
5. ***Rutherfordoides tenuis*** (Phleger and Parker) 89
   Locality PD-70.
   a. side view, ×110; b. ventral view, ×108; c. apertural view, ×98; d. dorsal view, ×108; e. enlargement of aperture, ×575; f. enlargement of cristate tooth, ×2900.

EXPLANATION OF PLATE 19

Figure	Page
1. ***Siphonodosaria hyugaensis*** (Ishizaki)	64
Locality PD-70. a. side view, ×54; b. apertural view, ×108; c. enlargement of aperture, oblique view, ×600; d. enlargement of aperture, top view, ×600.
2. ***Siphonodosaria oinomikadoi*** (Ishizaki)	64
Locality PD-35. a. side view, ×64; b. apertural view, ×72; c. enlargement of aperture, side view, ×562; d. enlargement of aperture, top view, ×500.
3. ***Stilostomella japonica*** (Ishizaki)	64
Locality PD-40. a. enlargement of last chamber showing spines, ×125; b. apertural view, ×70; c. side view, ×28; d. enlargement of spines on last chamber, ×1300.
4. ***Stilostomella lepidula*** (Schwager)	64
Locality PD-40. a. side view, ×60; b. apertural view, ×88; c. enlargement of neck, side view, ×300; d. enlargement of aperture, top view, ×342.
5. ***Stilostomella paucistriata*** (Galloway and Morrey)	65
Locality PD-35. a. side view, ×46; b. apertural view, ×58; c. enlargement of neck, side view, ×305; d. enlargement of aperture, top view, ×325; e. enlargement of constriction between ultimate and penultimate chambers, ×310.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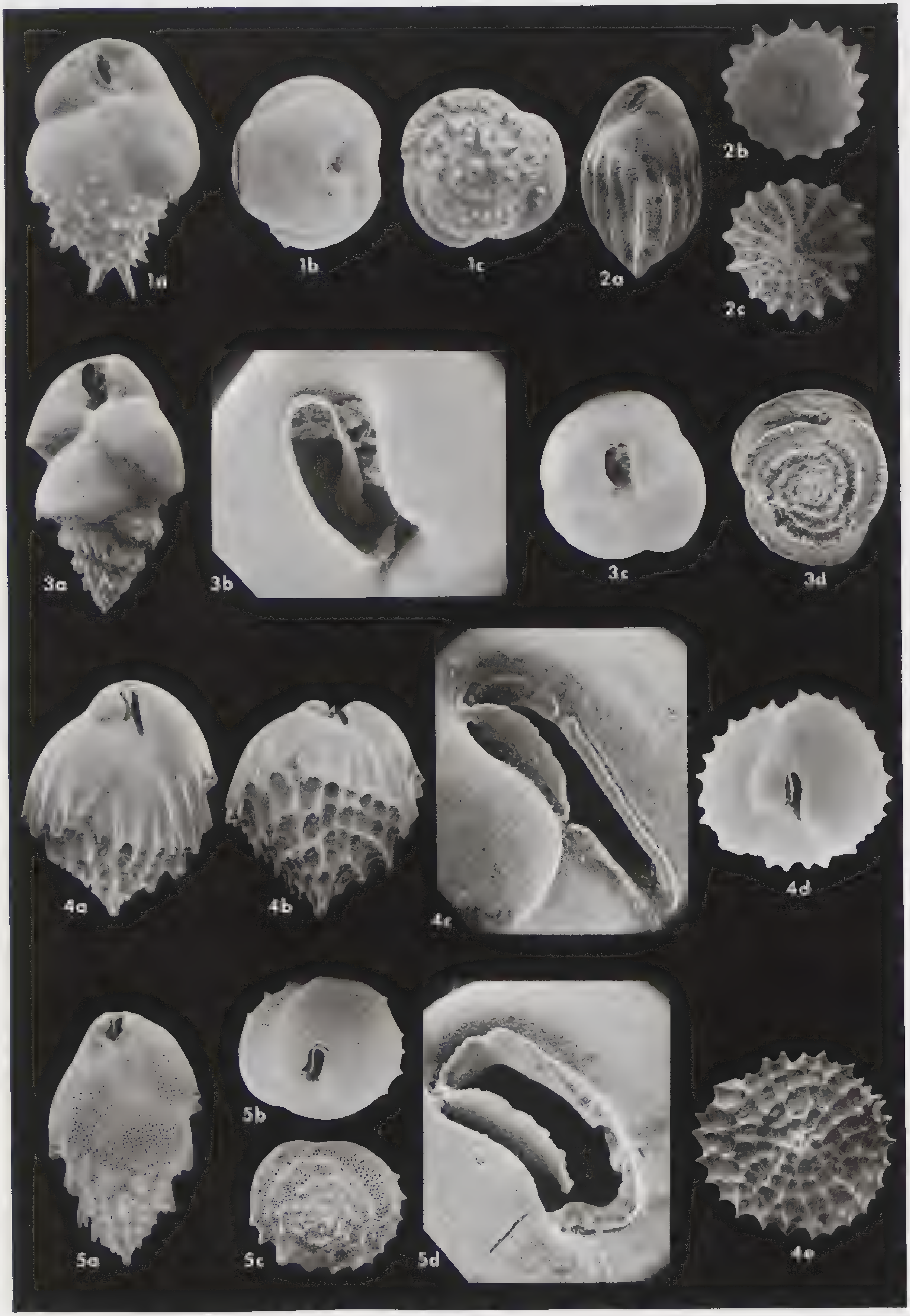
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Explanation of Plate 20

Figure Page

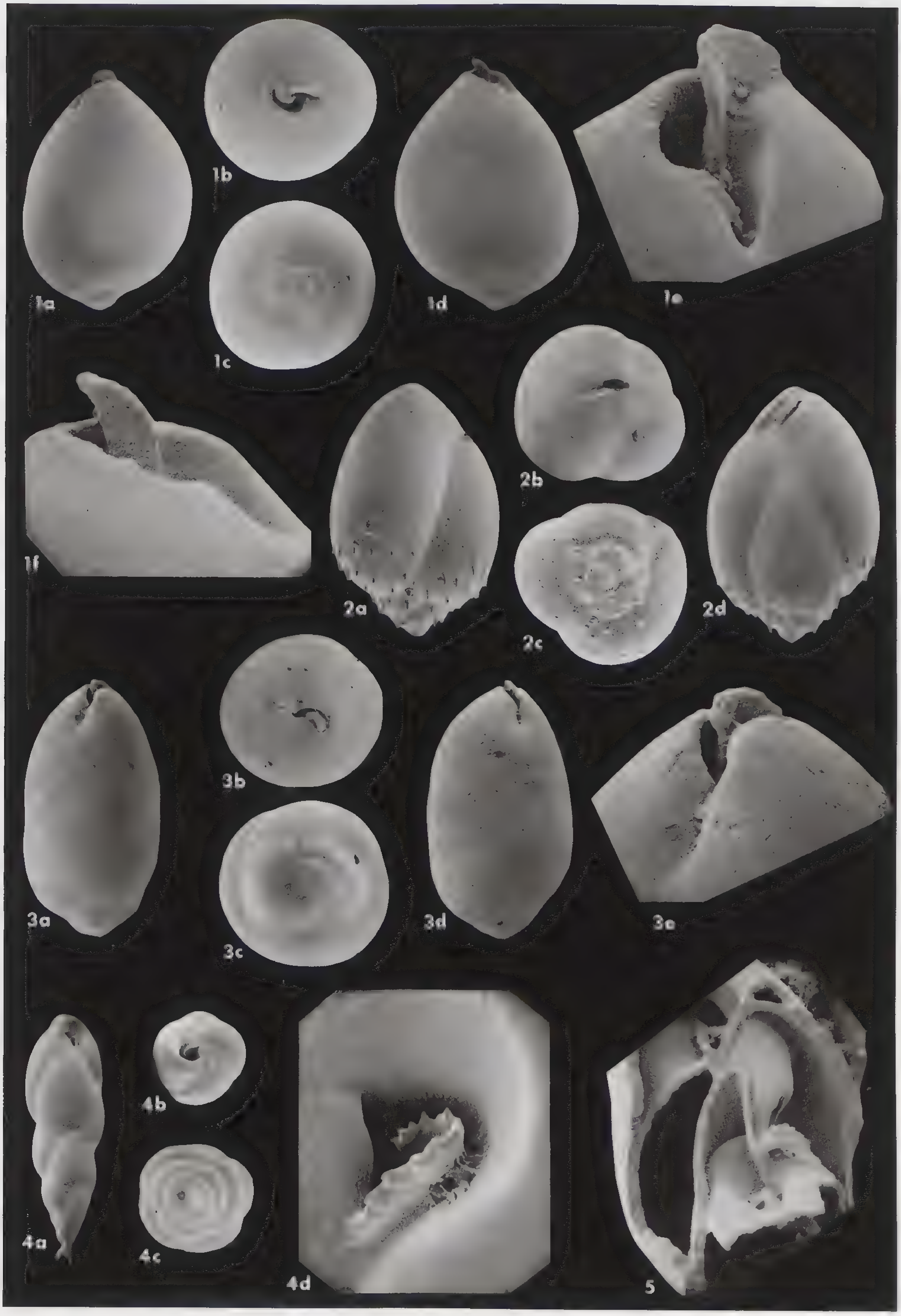
1. ***Bulimina aculeata*** d'Orbigny 65
Locality PD-35.
a. side view, ×142; b. apertural view, ×140; c. basal view, ×140.
2. ***Bulimina alazanensis*** Cushman 66
Locality SD-12.
a. side view, ×72; b. apertural view, ×88; c. basal view, ×85.
3. ***Bulimina marginata*** d'Orbigny 66
Locality PD-49.
a. side view, ×86; b. enlargement of aperture with toothplate, ×580; c. apertural view, ×90; d. basal view, ×90.
4. ***Bulimina striata mexicana*** Cushman 67
Locality PD-70.
a. side view, ×58; b. oblique view, detail of costae, ×58; c. enlargement of aperture with toothplate, ×252; d. apertural view, ×58; e. basal view, ×58.
5. ***Bulimina spicata*** Phleger and Parker 66
Locality PD-70.
a. side view, ×92; b. apertural view, ×100; c. basal view, ×94; d. enlargement of aperture with toothplate, ×500.

EXPLANATION OF PLATE 21

Figure Page

1. ***Globobulimina pacifica*** Cushman 67
   Locality PD-63.
   a. side view, ×74; b. apertural view, ×74; c. basal view, ×74; d. opposite side, ×76; e. enlargement of aperture with toothplate, ×345; f. enlargement of fig. 1d showing toothplate, ×342.
2. ***Praeglobobulimina spinescens*** (Brady) 68
   Locality PD-38.
   a. side view, ×132; b. apertural view, ×130; c. basal view, ×135; d. opposite side, ×130.
3. ***Praeglobobulimina ovata*** (d'Orbigny) 67
   Locality PD-58.
   a. side view, ×44; b. apertural view, ×46; c. basal view, ×50; d. side view, 90° from fig. 3a, ×42; e. enlargement of fig. 3a showing toothplate, ×158.

4–5. ***Stainforthia*** cf. ***S. concava*** (Höglund) 68
   Locality PD-76.
   4. a. side view, ×68; b. apertural view, ×78; c. basal view, ×85; d. enlargement of aperture with toothplate, ×550.
   5. Dissected specimen showing relationship of toothplate to aperture, ×275.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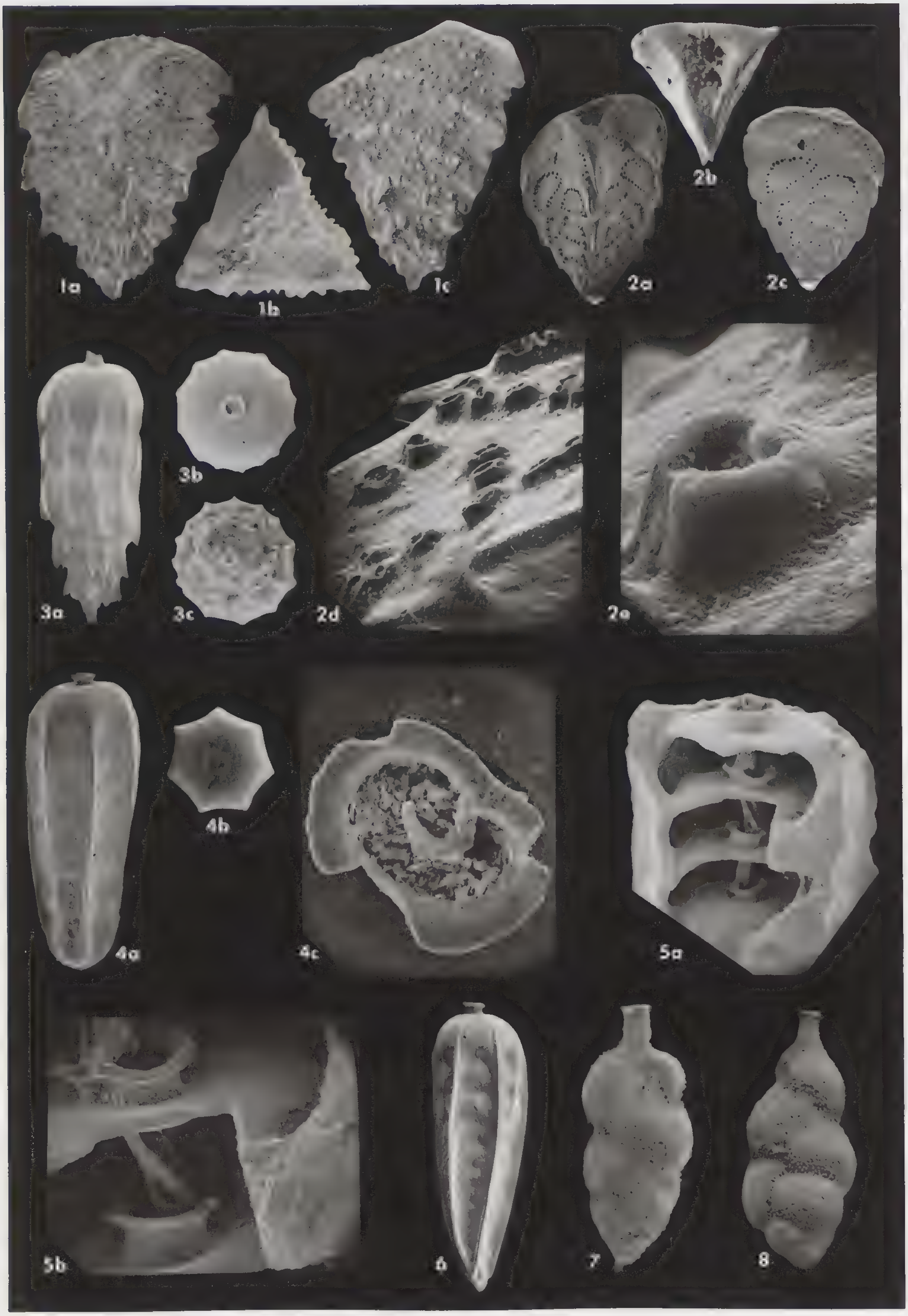
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Explanation of Plate 22

Figure Page

1. **Reussella pulchra** Cushman 69
   Locality PD-68.
   a. side view, ×68; b. apertural view, ×88; c. opposite side, ×92.
2. **Reussella spinulosa** (Reuss) 69
   Locality SD-4.
   a. side view, ×58; b. apertural view, ×56; c. opposite side, ×58; d. enlargement of pores showing elevated rims, ×440; e. detail of pore rim, ×2300.
3. **Rectuvigerina basispinata** (Cushman and Jarvis) 69
   Locality SD-4.
   a. side view, ×48; b. apertural view, ×58; c. basal view, ×60.

4–6. **Rectuvigerina lamellata** (Cushman) 70
   Locality SD-4.
   4. a. side view, megalospheric form, ×50; b. apertural view, ×44; c. enlargement of aperture, top view, ×425.
   Locality PD-35.
   5. a. dissected specimen showing relationship of toothplate, ×90; b. enlargement of fig. 5a, with detail of toothplate, ×240.
   6. Side view, microspheric form, ×36.

7–8. **Siphouvigerina auberiana** (d'Orbigny) 70
   Locality PD-58.
   7. Side view, ×94.
   Locality SD-4.
   8. Side view, ×62.

EXPLANATION OF PLATE 23

Figure Page

1. ***Siphouvigerina auberiana*** (d'Orbigny) 70
Locality PD-58.
a. side view, ×75; b. apertural view, ×96; c. basal view, ×102; d. enlargement of aperture with toothplate, top view, ×575; e. enlargement of neck and aperture, oblique view, ×588.

2. ***Trifarina rutila*** (Cushman and Todd) 71
Locality PD-68.
a. side view, ×95; b. apertural view, ×100; c. basal view, ×108; d. enlargement of broken chamber showing toothplate, ×225.

3. ***Trifarina*** cf. ***T. fornasinii*** (Selli) 71
Locality SD-4.
a. side view, ×50; b. apertural view, ×60; c. basal view, ×68; d. enlargement of neck and aperture, ×243.

4–5. ***Uvigerina crassicostata*** Schwager 72
Locality PD-68.
4. Side view, ×36.
5. a. side view, ×36; b. apertural view, ×38; c. basal view, ×38; d. opposite side, ×36; e. enlargement of fig. 5d showing costae on initial portion, ×90.

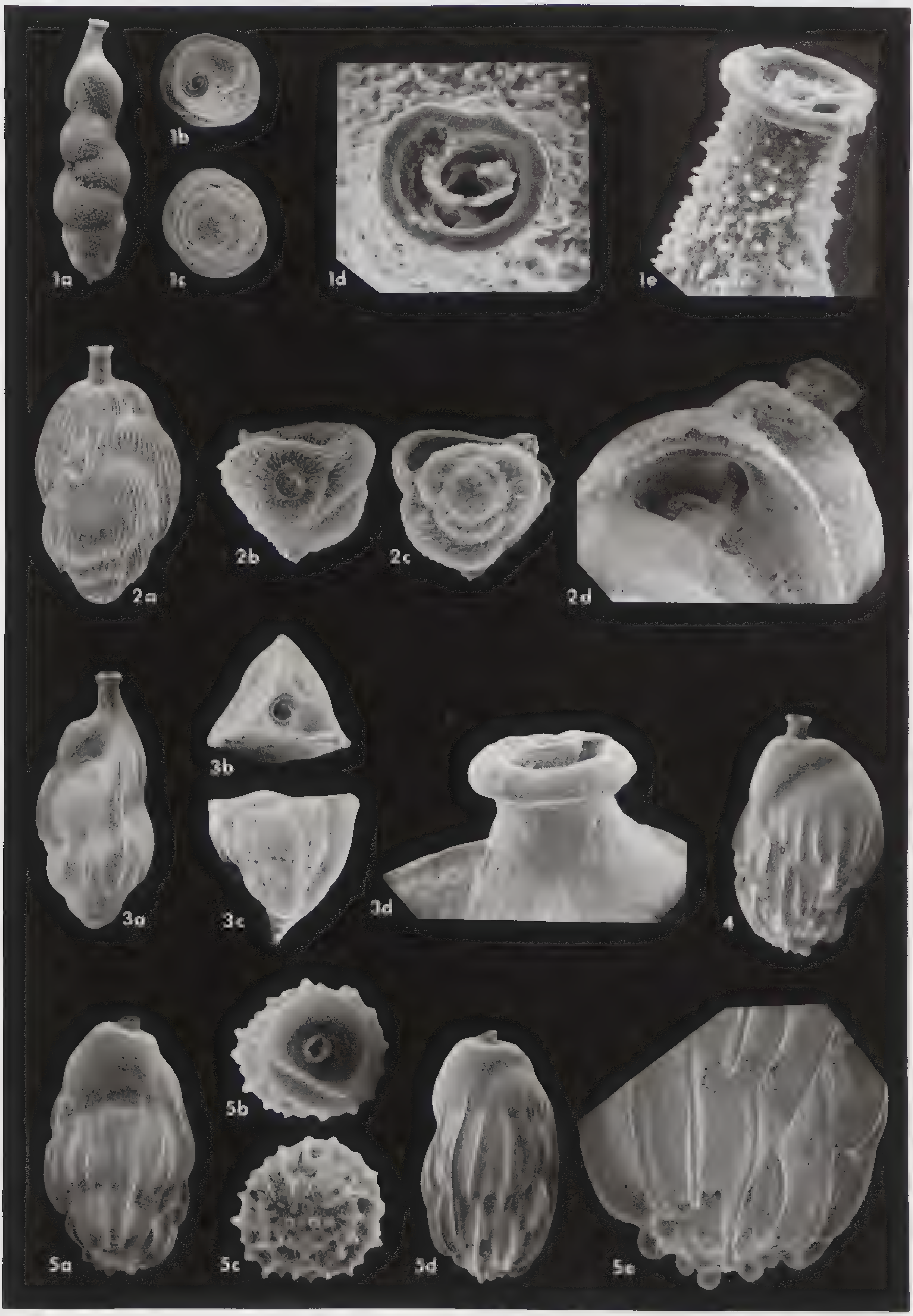
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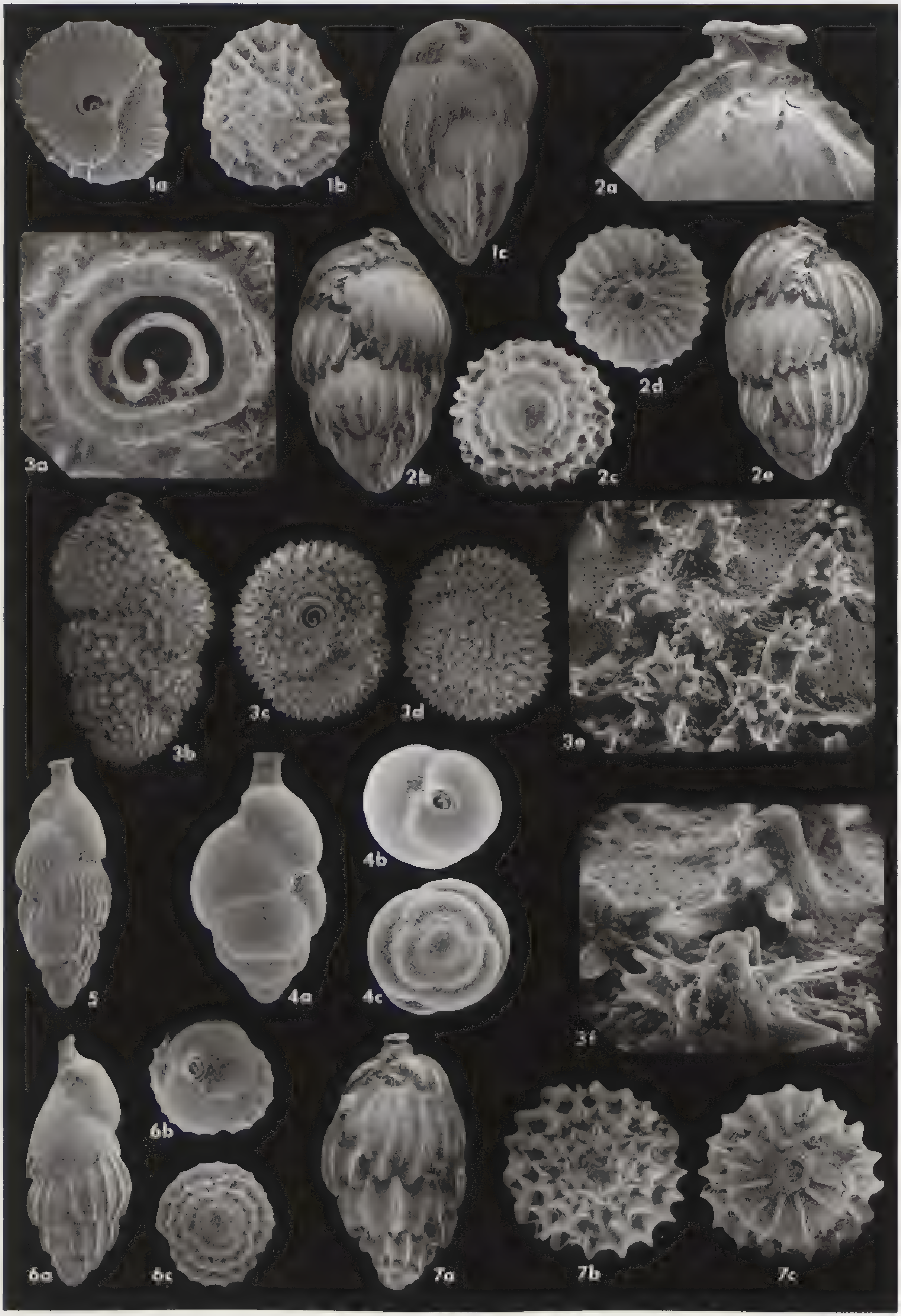
PLATE 24



EXPLANATION OF PLATE 24

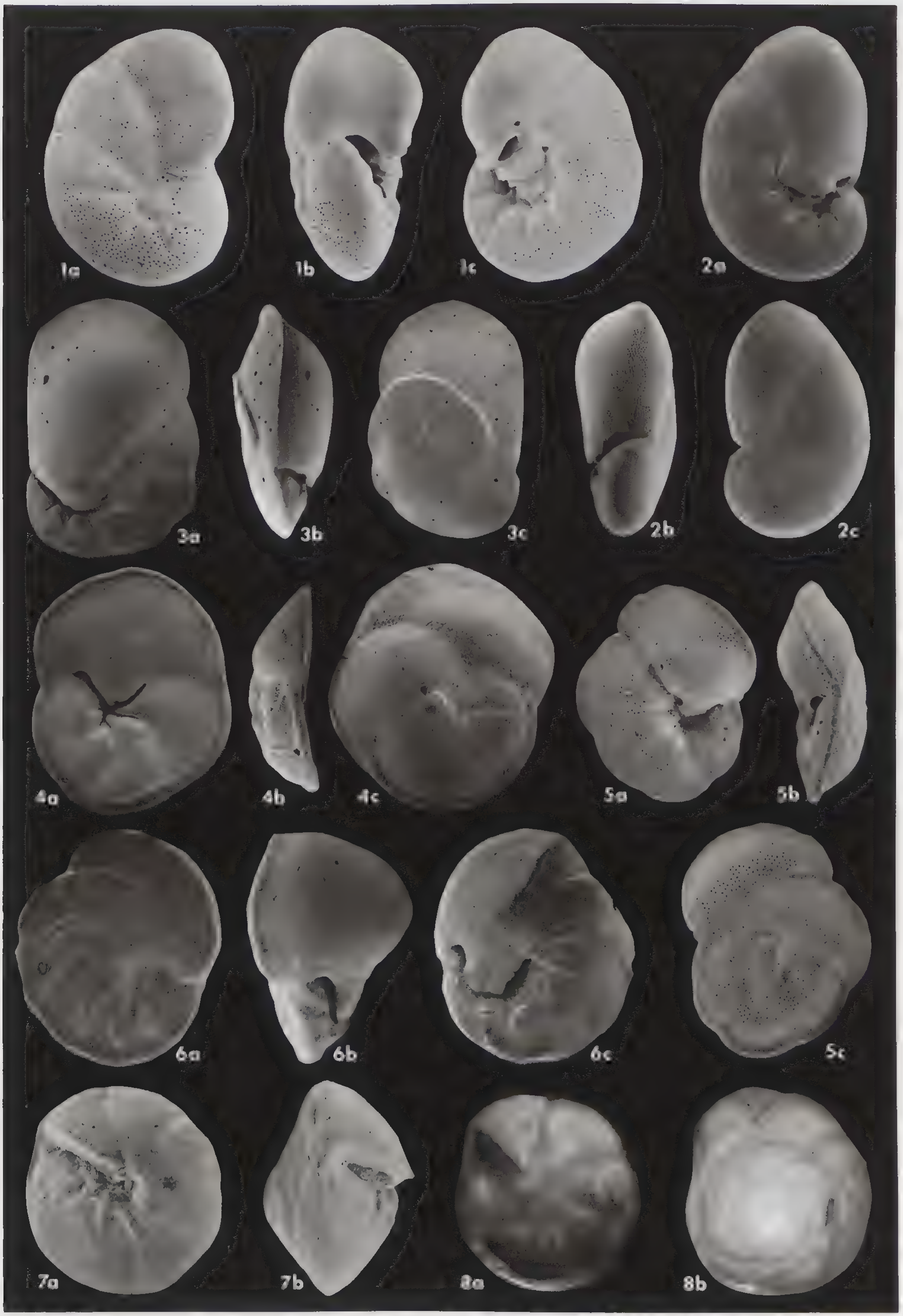
Figure		Page
1.	***Uvigerina charltonae*** Palmer Locality PD-72. a. apertural view, ×54; b. basal view, ×52; c. side view, ×50.	72
2.	***Uvigerina*** species A Locality SD-4. a. enlargement of neck and rim of aperture, ×235; b. side view, ×62; c. basal view, ×64; d. apertural view, ×60; e. side view, 90° from fig. 2b, ×62.	71
3.	***Uvigerina hispida*** Schwager Locality PD-70. a. enlargement of aperture and toothplate, ×262; b. side view, ×46; c. apertural view, ×48; d. basal view, ×48; e. enlargement of spines on early portion of test, ×440; f. detail of fig. 3e showing rosette of smaller spines radiating from primary spine, ×875.	72
4.	***Uvigerina mantaensis*** Cushman and Edwards Locality SD-4. a. side view, ×96; b. apertural view, ×96; c. basal view, ×102.	73
5–6.	***Uvigerina parvula*** Cushman Locality PD-40. 5. Side view, ×92. 6. a. side view, ×102; b. apertural view, ×118; c. basal view, ×118.	73
7.	***Uvigerina peregrina*** Cushman Locality PD-54. a. side view, ×70; b. basal view, ×90; c. apertural view, ×88.	73

EXPLANATION OF PLATE 25

Figure — Page

1. ***Valvulineria mexicana*** Parker 74
   Locality PD-38.
   a. spiral side, ×108; b. edge view, ×104; c. umbilical side, ×104.
2. ***Valvulineria nuttalli*** Palmer and Bermudez 75
   Locality SD-4.
   a. umbilical view, ×44; b. edge view, ×42; c. spiral view, ×42.
3. ***Cancris communis*** Cushman and Todd 74
   Locality SD-4.
   a. umbilical view, ×44; b. edge view, ×40; c. spiral view, ×40.
4. ***Discorbinella floridensis*** (Cushman) 75
   Locality SD-4.
   a. umbilical view, ×44; b. edge view, ×40; c. spiral view, ×46.
5. ***Rosalina*** species A 76
   Locality PD-66.
   a. umbilical view, ×66; b. edge view, ×68; c. spiral view, ×70.
6. ***Cibicorbis herricki*** Hadley 76
   Locality SD-4.
   a. spiral view, ×44; b. edge view, ×44; c. umbilical view, ×42.

7–8. ***Neoeponides parantillarum*** (Galloway and Heminway) 76
   Locality PD-46.
   7. a. umbilical view, ×30; b. edge view, ×30.
   Locality PD-56.
   8. a. umbilical view, reflected light, ×68; b. spiral view, reflected light, ×68.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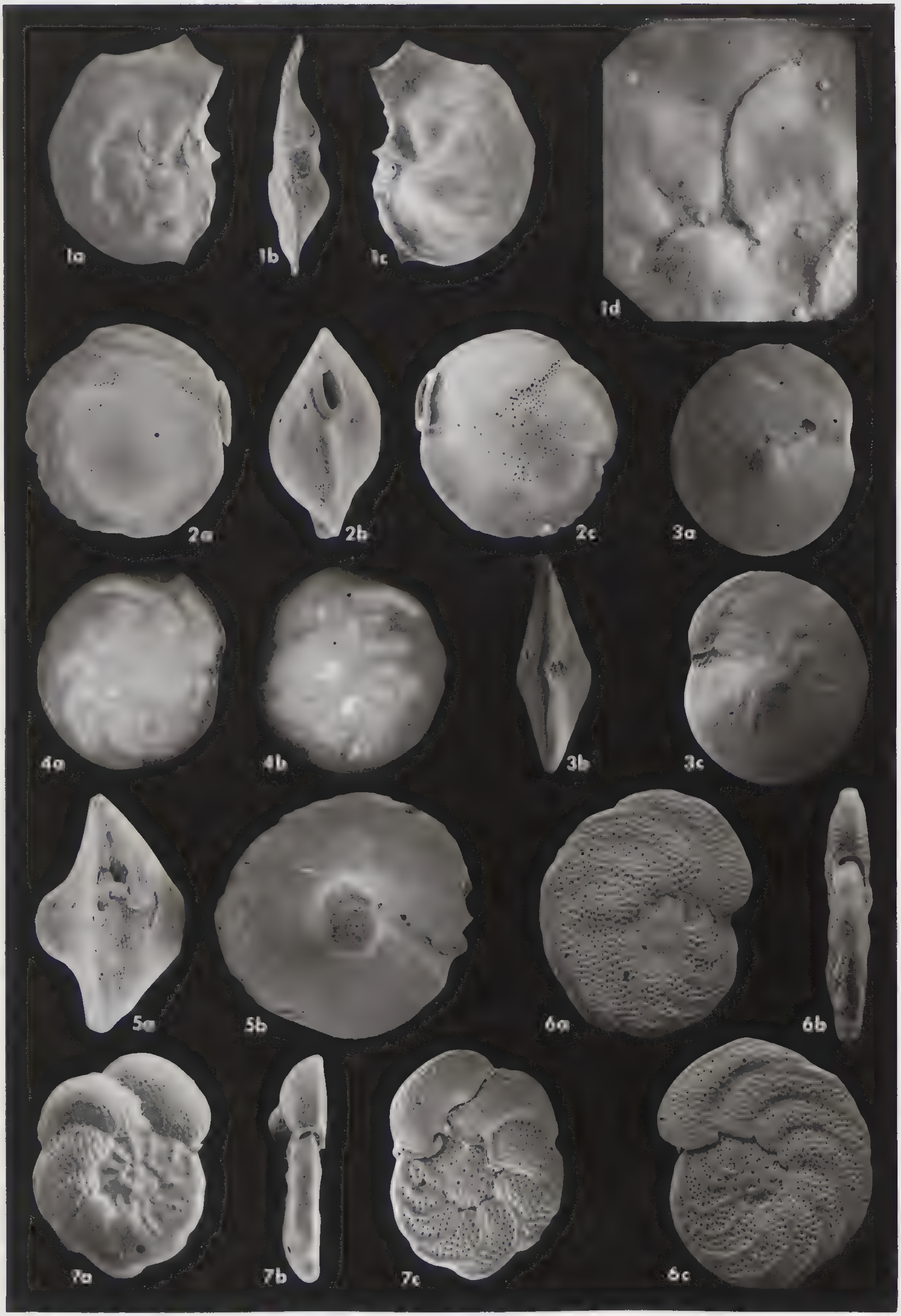
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EXPLANATION OF PLATE 26

Figure Page

1. ***Laticarinina pauperata*** (Parker and Jones) 77
Locality PD-68.
a. side view, ×66; b. edge view, ×68; c. opposite side, ×64; d. enlargement of attachment flange on flattened side, ×235.

2. ***Siphonina pozonensis*** Cushman and Renz 77
Locality PD-52.
a. spiral view, ×56; b. edge view, ×58; c. umbilical view, ×56.

3–4. ***Amphistegina gibbosa*** d'Orbigny 78
Locality SD-4.
3. a. spiral view, ×36; b. edge view, ×36; c. umbilical view, ×36.
Locality SD-12.
4. a. spiral view, reflected light, ×65; b. umbilical view, reflected light, ×65.

5. ***Amphistegina*** species A 77
Locality SD-4.
a. edge view, ×24; b. spiral view, ×24.

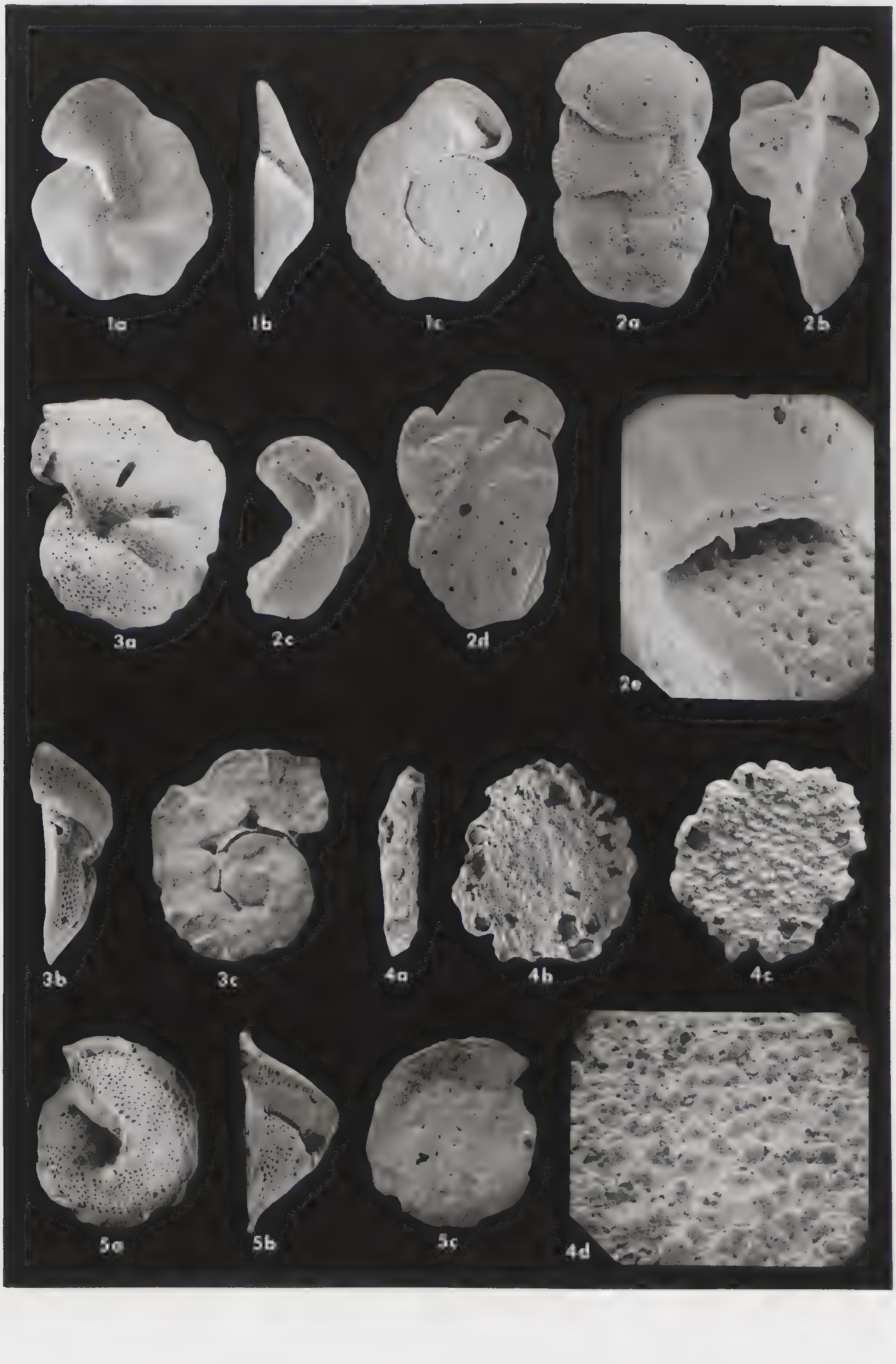
6. ***Planulina ariminensis*** d'Orbigny 78
Locality SD-4.
a. spiral view, ×44; b. edge view, ×46; c. umbilical view, ×44.

7. ***Planulina exorna*** Phleger and Parker 78
Locality SD-4.
a. spiral view, ×74; b. edge view, ×76; c. umbilical view, ×74.

EXPLANATION OF PLATE 27

Figure Page

1. ***Cibicides refulgens*** Montfort 79
   Locality SD-4.
   a. umbilical view, ×36; b. edge view, ×36; c. spiral view, ×36.
2. ***Dyocibicides biserialis*** Cushman and Valentine 79
   Locality SD-4.
   a. umbilical view, ×70; b. edge view, ×64; c. top view, ×68; d. spiral view, ×60; e. enlargement of aperture, ×288.
3. ***Montfortella bramlettei*** Loeblich and Tappan 80
   Locality SD-4.
   a. umbilical view, ×62; b. edge view, ×65; c. spiral view, ×58.
4. ***Planorbulinella larvata*** (Parker and Jones) 80
   Locality SD-9.
   a. edge view, ×38; b. spiral view, ×38; c. ventral view, ×36; d. enlargement of ventral surface showing elongate knobs, ×120.
5. ***Carpenteria balaniformis*** Gray 80
   Locality SD-4.
   a. umbilical view, ×54; b. edge view, ×54; c. spiral view, ×54.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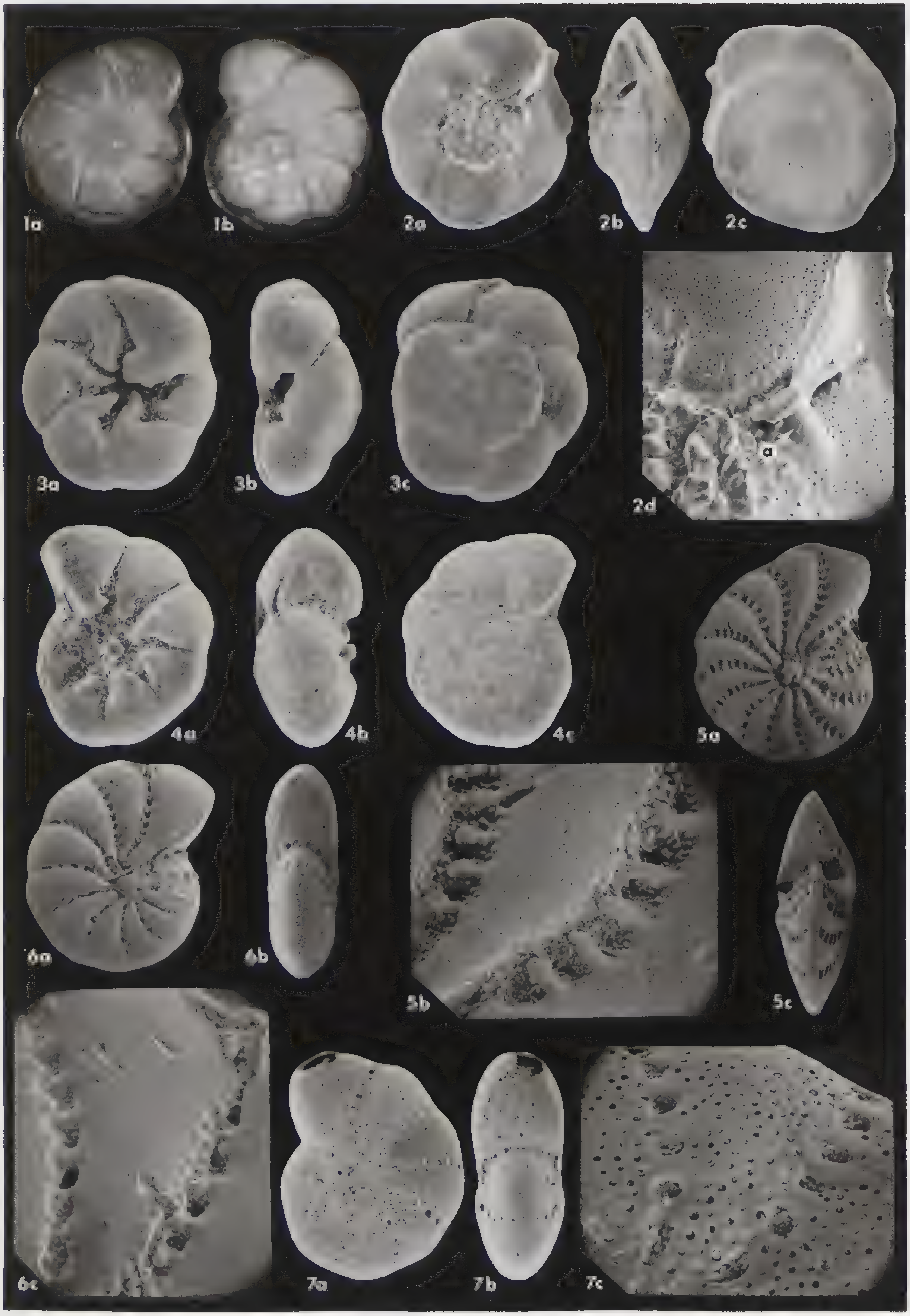
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Explanation of Plate 28

Figure Page

1–2. ***Discorbis? olutensis,*** new species 82
Locality SD-4.
1. Holotype (USNM 400653): a. umbilical view, reflected light, ×100; b. spiral view, reflected light, ×100.
Locality PD-35.
2. Paratype (USNM 400654): a. umbilical view, ×96; b. edge view, ×96; c. spiral view, ×100; d. detail of infolding of wall of ultimate chamber (a), ×288.

3. ***Ammonia tepida*** (Cushman) 81
Locality PD-66.
a. umbilical view, ×98; b. edge view, ×98; c. spiral view, ×98.

4. ***Ammonia parkinsoniana*** (d'Orbigny) 81
Locality PD-66.
a. umbilical view, ×106; b. edge view, ×104; c. spiral view, ×104.

5. ***Elphidium advenum*** (Cushman) 83
Locality PD-66.
a. side view, ×70; b. enlargement of retral processes, ×348; c. edge view, ×70.

6. ***Elphidium incertum*** (Williamson) 83
Locality PD-66.
a. side view, ×84; b. edge view, ×82; c. enlargement of retral processes, ×320.

7. ***Elphidium poeyanum*** (d'Orbigny) 84
Locality SD-21.
a. side view, ×104; b. edge view, ×104; c. enlargement of retral processes, ×362.

EXPLANATION OF PLATE 29

Figure — Page

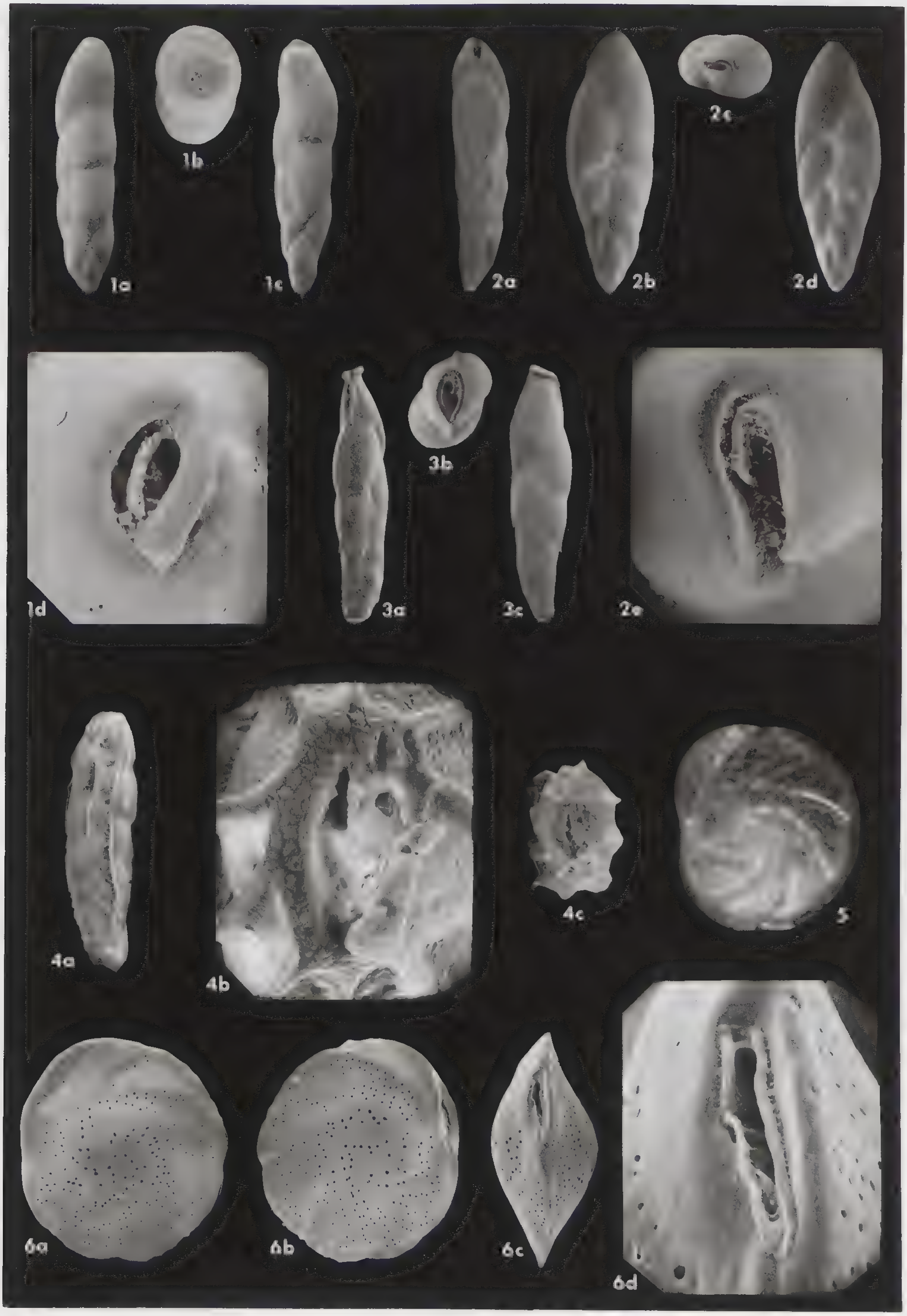
1. ***Fursenkoina bramlettei*** (Galloway and Morrey) 84
Locality PD-35.
a. side view, ×58; b. apertural view, ×88; c. opposite side, ×58; d. enlargement of aperture, ×460.

2. ***Fursenkoina pontoni*** (Cushman) 84
Locality SD-4.
a. edge view, ×60; b. side view, ×60; c. apertural view, ×58; d. opposite side, ×58; e. enlargement of aperture, ×325.

3. ***Loxostomum bradyi*** (Asano) 85
Locality PD-68.
a. side view, ×68; b. enlargement of aperture, ×108; c. apertural view, ×66.

4. ***Loxostomum*** species A 85
Locality PD-40.
a. side view, ×115; b. enlargement of aperture, ×915; c. apertural view, ×85.

5–6. ***Cassidulina curvata*** Phleger and Parker 85
Locality PD-35.
5. Side view, reflected light, ×132.
6. a. side view, ×120; b. opposite side, ×120; c. edge view, ×125; d. enlargement of aperture, ×550.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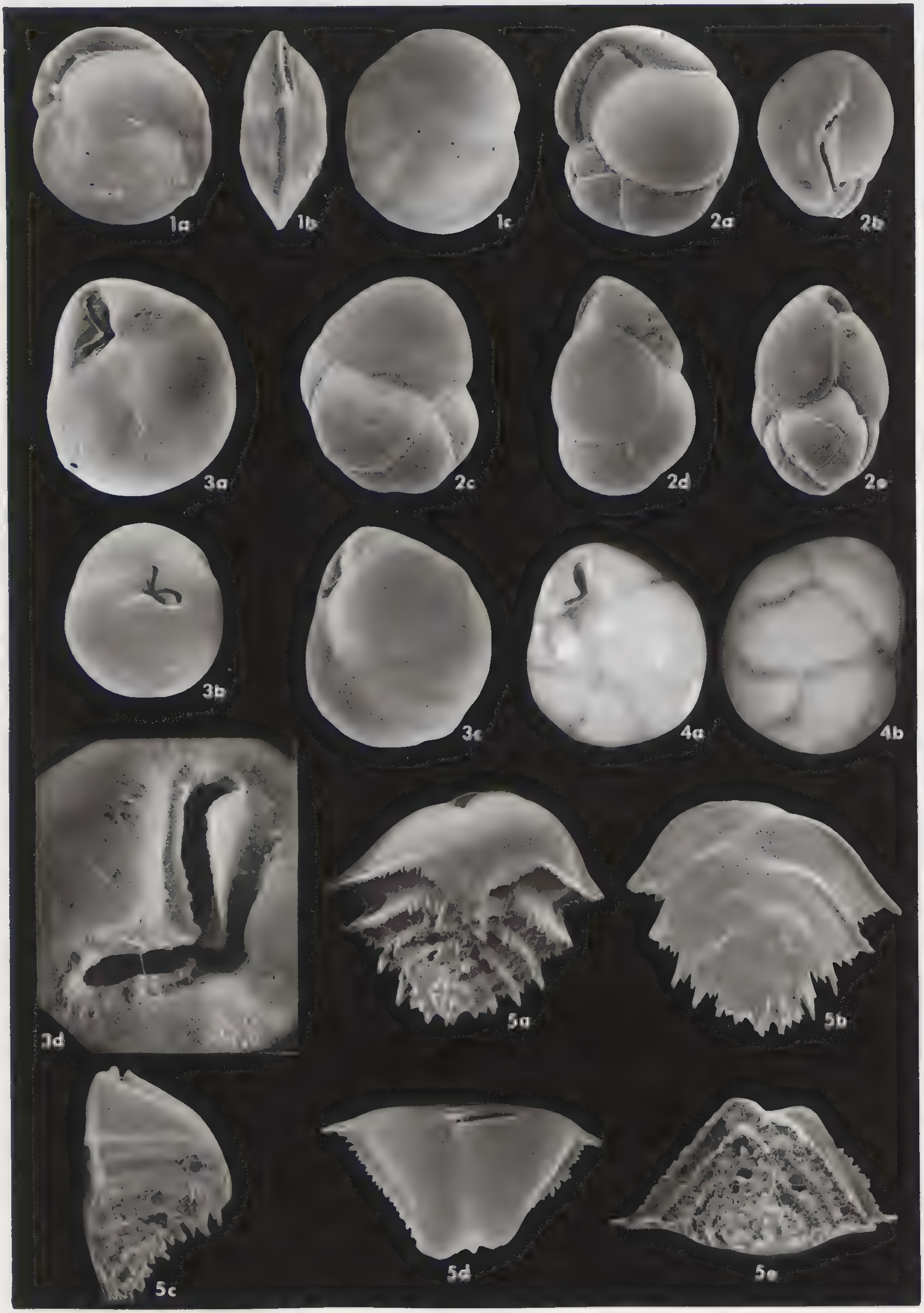
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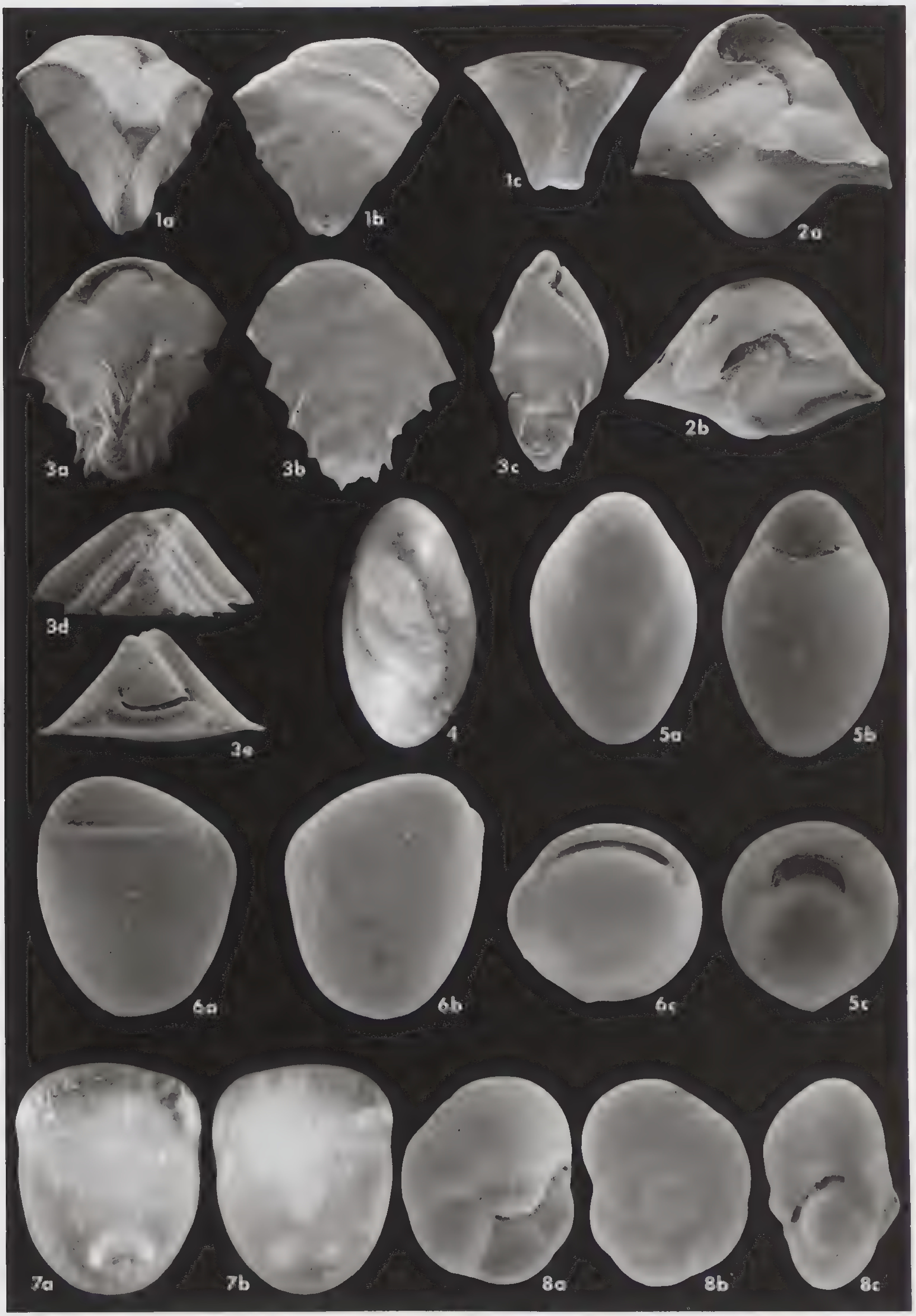
EXPLANATION OF PLATE 30

Figure		Page
1.	**Cassidulina neocarinata** Thalmann Locality PD-63. a. side view, ×150; b. edge view, ×150; c. opposite side, ×150.	86
2.	**Lernella inflata** (LeRoy) Locality PD-63. a. side view, ×115; b. top view, ×110; c. opposite side view, ×115; d. edge view, ×115; e. opposite edge view, ×115.	88
3–4.	**Globocassidulina subglobosa** (Brady) Locality SD-4. 3. a. side view, ×76; b. apertural view, ×68; c. side view, 90° from fig. 3a, ×76; d. enlargement of aperture, ×320. Locality PD-37. 4. a. side view, reflected light, ×80; b. opposite side view, ×78.	88
5.	**Ehrenbergina olmeca,** new species Locality PD-70. Holotype (USNM 400657): a. ventral view, ×118; b. dorsal view, ×118; c. side view, ×118; d. apertural view, ×110; e. basal view, ×118.	86

EXPLANATION OF PLATE 31

Figure		Page
1.	***Ehrenbergina bosoensis*** Takayanagi Locality SD-12. a. ventral view, ×76; b. dorsal view, ×76; c. apertural view, ×70.	86
2.	***Ehrenbergina spinea*** Cushman Locality PD-43. a. ventral view, ×125; b. apertural view, ×128.	87
3.	***Ehrenbergina undulata*** Parker Locality SD-4. a. ventral view, ×102; b. dorsal view, ×108; c. edge view, ×102; d. basal view, ×102; e. apertural view, ×110.	87
4–5.	***Chilostomella czizeki*** Reuss Locality PD-70. 4. Dorsal view, reflected light, ×75. Locality SD-4. 5. a. dorsal view, ×108; b. ventral view, ×90; c. apertural view, ×92.	90
6–7.	***Allomorphina macrostoma*** Karrer Locality PD-70. 6. a. ventral view, ×85; b. dorsal view, ×85; c. apertural view, ×85. Locality PD-68. 7. a. ventral view, reflected light, ×84; b. dorsal view, reflected light, ×84.	90
8.	***Quadrimorphina glabra*** (Cushman) Locality PD-76. a. umbilical view, ×135; b. spiral view, ×135; c. edge view, ×135.	90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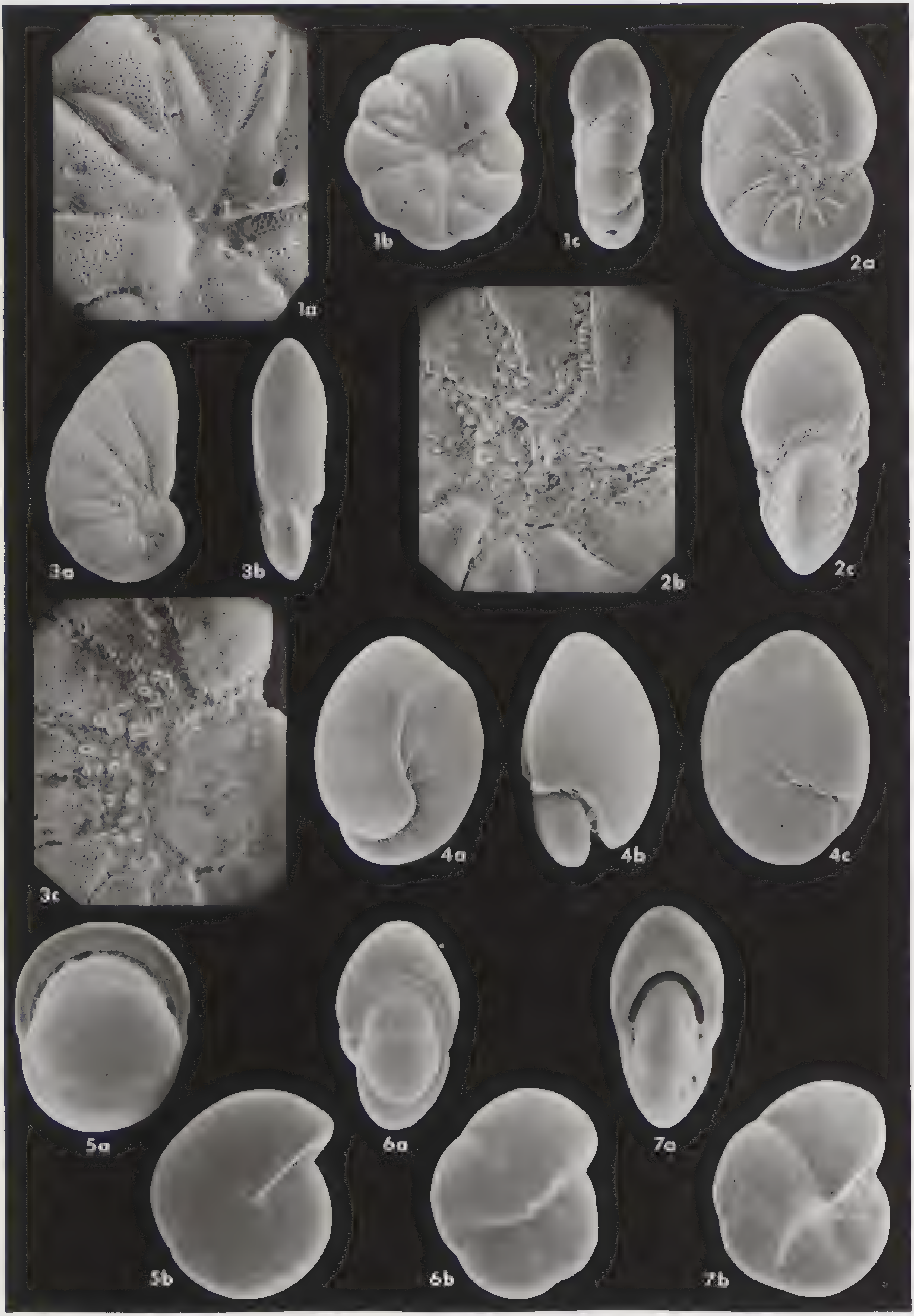
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EXPLANATION OF PLATE 32

Figure Page

1. ***Astrononion gallowayi*** (Loeblich and Tappan) 91
   Locality SD-12.
   a. enlargement showing umbilical extensions and supplemental openings, ×155; b. side view, ×68; edge view, ×68.
2. ***Florilus atlanticus*** (Cushman) 91
   Locality SD-29.
   a. ventral view, ×84; b. enlargement of umbilical area showing granular filling, ×238; c. edge view, ×90.
3. ***Florilus grateloupi*** (d'Orbigny) 92
   Locality SD-29.
   a. dorsal view, ×72; b. edge view, ×72; c. enlargement of dorsal side showing deposits along sutures, ×270.
4. ***Nonionella basiloba*** Cushman and McCulloch 92
   Locality PD-35.
   a. ventral view, ×122; b. edge view, ×125; c. dorsal view, ×125.
5. ***Pullenia bulloides*** (d'Orbigny) 92
   Locality PD-37.
   a. edge view, ×92; b. side view, ×92.
6. ***Pullenia quinqueloba*** (Reuss) 93
   Locality PD-38.
   a. edge view, ×100; b. side view, ×100.
7. ***Pullenia salisburyi*** Stewart and Stewart 93
   Locality PD-68.
   a. edge view, ×104; b. side view, ×104.

EXPLANATION OF PLATE 33

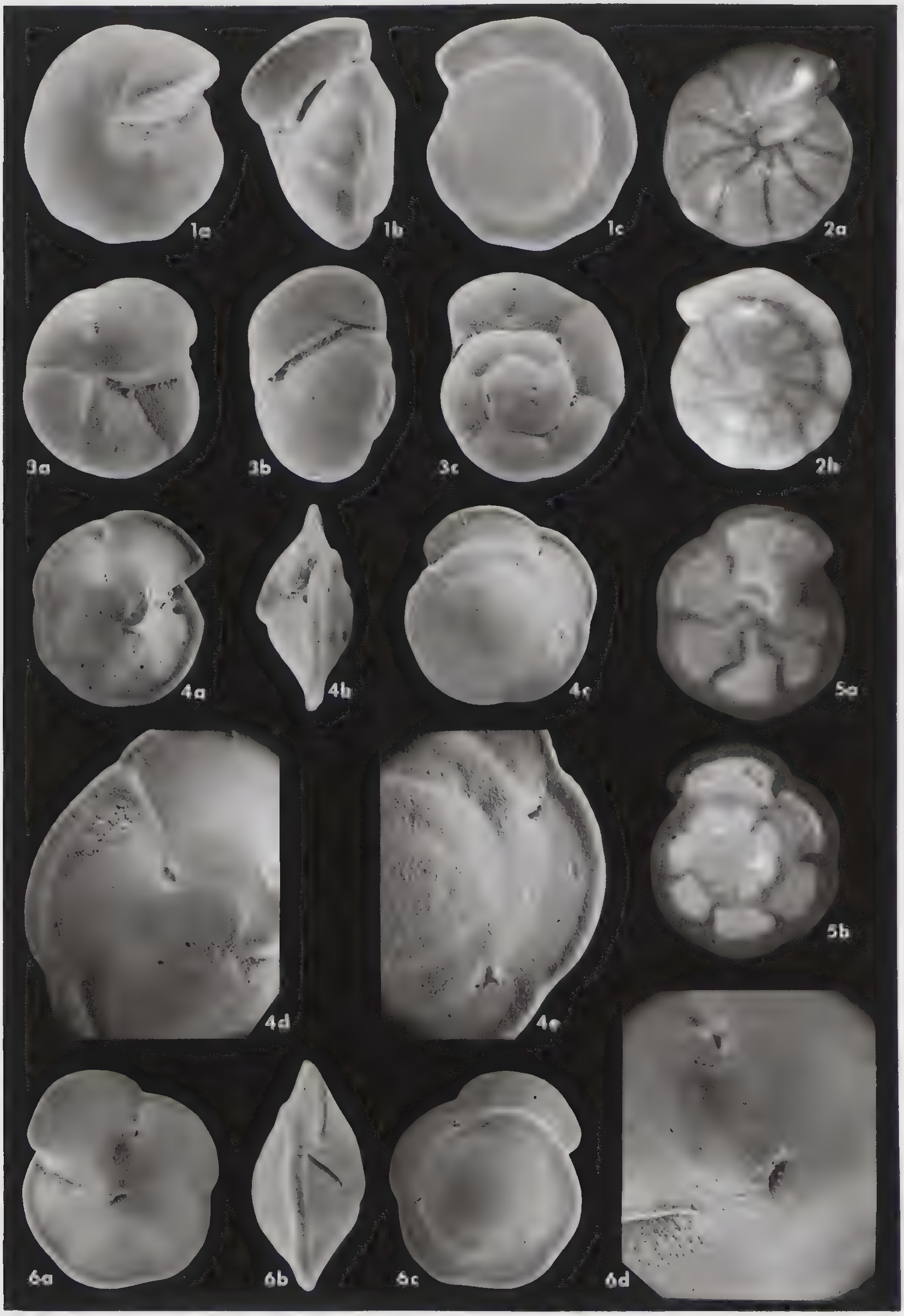
Figure — Page

1–2. ***Gyroidina orbicularis*** d'Orbigny 93
   Locality PD-68.
   1. a. umbilical view, ×190; b. edge view, ×90; c. spiral view, ×94.
   Locality PD-70.
   2. a. umbilical view, reflected light, ×98; b. spiral view, reflected light, ×94.

3. ***Gyroidina umbonata*** (Silvestri) 94
   Locality PD-54.
   a. umbilical view, ×148; b. edge view, ×145; c. spiral view, ×145.

4–5. ***Oridorsalis stellatus*** (Silvestri) 94
   Locality SD-4.
   4. a. umbilical view, ×80; b. edge view, ×80; c. spiral view, ×82; d. enlargement of supplemental apertures on umbilical side, ×162; e. enlargement of supplemental apertures on spiral side, ×155.
   5. a. umbilical view, reflected light, ×82; b. spiral view, reflected light, ×82.

6. ***Oridorsalis umbonatus*** (Reuss) 95
   Locality PD-81.
   a. umbilical view, ×82; b. edge view, ×82; c. spiral view, ×80; d. enlargement of supplemental apertures on umbilical side, ×180.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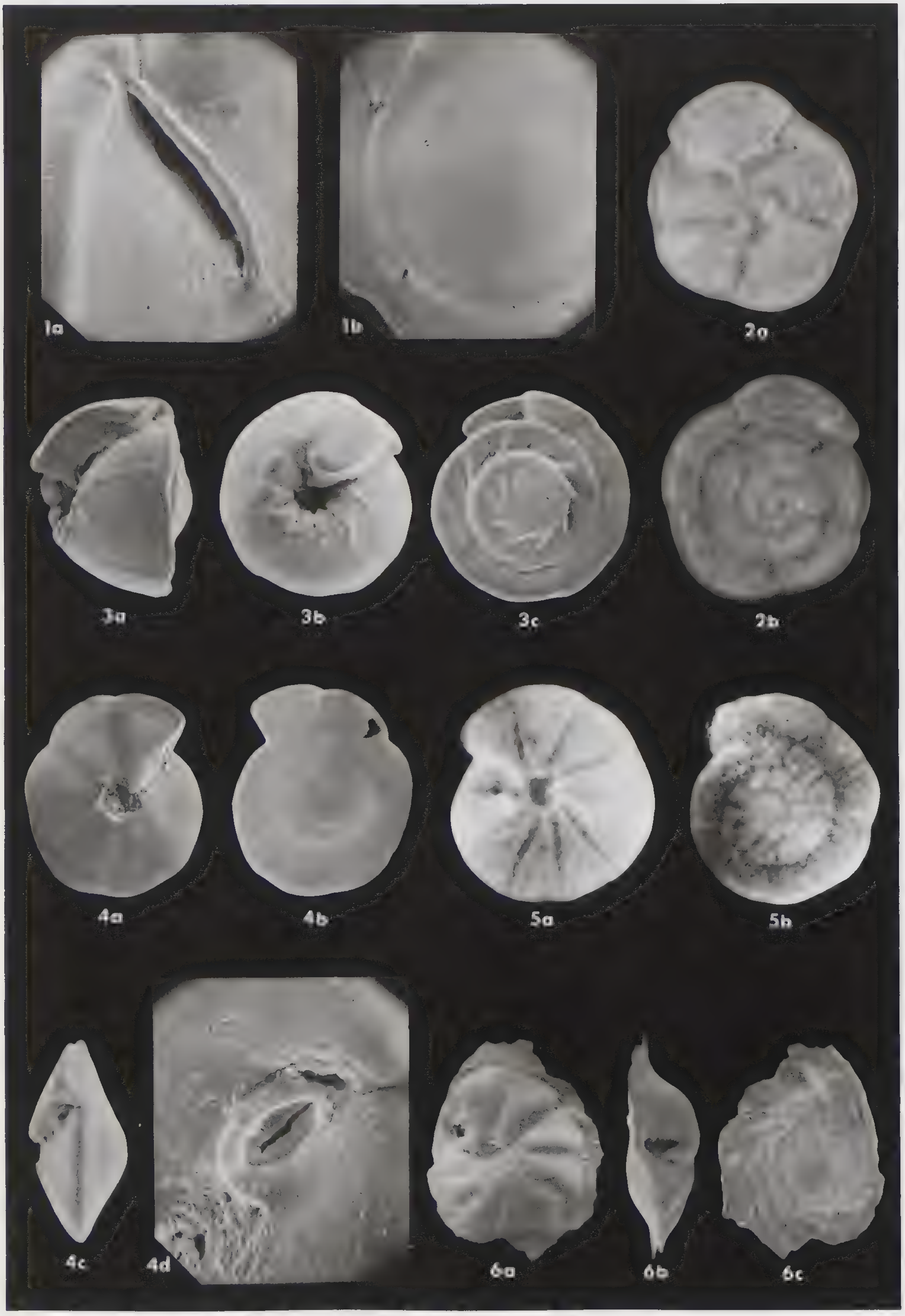
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EXPLANATION OF PLATE 34

Figure .... Page

1–2. ***Oridorsalis umbonatus*** (Reuss) 95
Locality PD-81.
1. a. enlargement of primary aperture (from Pl. 33, fig. 6b), ×235; b. enlargement of supplemental apertures, spiral side (from Pl. 33, fig. 6c), ×162.
Locality PD-37.
2. a. umbilical view, reflected light, ×86; b. spiral view, reflected light, ×86.

3. ***Gyroidinoides altiformis*** (Stewart and Stewart) 95
Locality PD-35.
a. edge view, ×50; b. umbilical view, ×52; c. spiral view, ×50.

4–5. ***Gyroidina? regularis*** (Phleger and Parker) 94
Locality PD-37.
4. a. umbilical view, ×135; b. spiral view, ×140; c. edge view, ×135; d. enlargement of aperture, ×900.
Locality PD-45.
5. a. umbilical view, reflected light, ×142; b. spiral view, reflected light, ×142.

6. ***Osangularia culter*** (Parker and Jones) 96
Locality PD-70.
a. umbilical view, ×60; b. edge view, ×62; c. spiral view, ×58.

EXPLANATION OF PLATE 35

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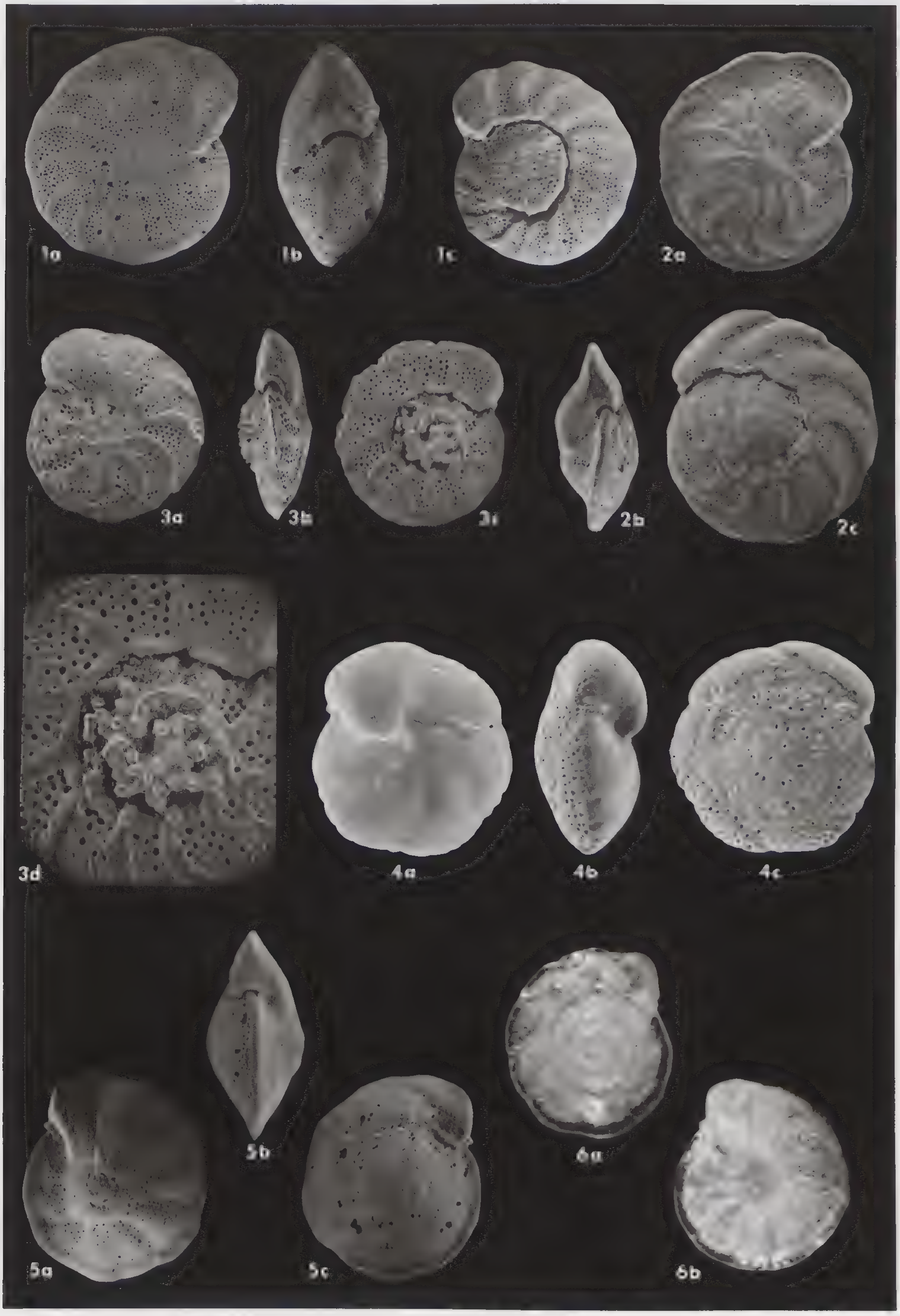
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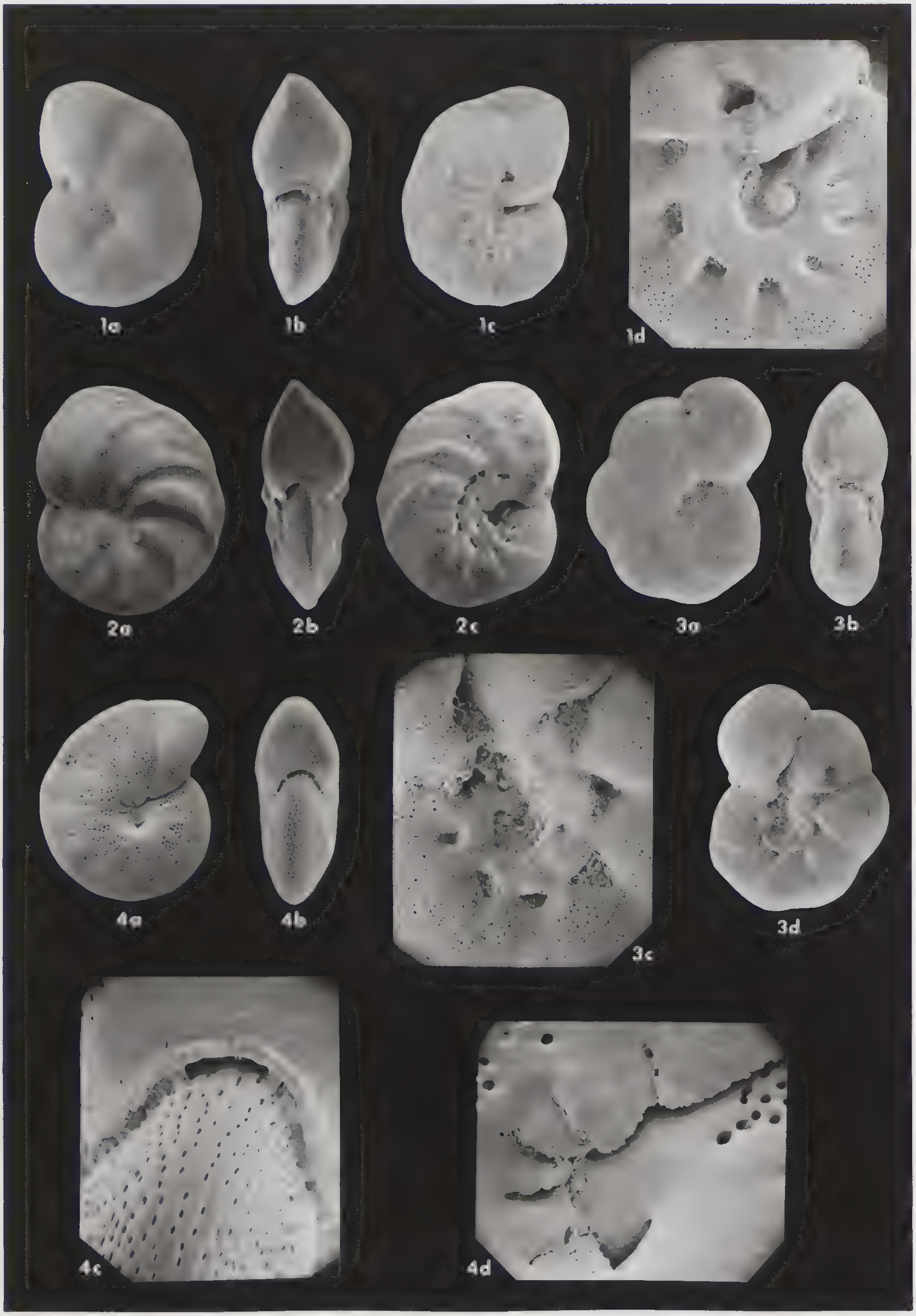
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Locality PD-35.

Holotype (USNM 400649): a. enlargement of neck (same specimen as Pl. 7, fig. 1), ×250; b. enlargement of lower portion of neck with detail of triradiate process on spine, ×2500; c. enlargement of area at base of neck with detail of spines, side view, ×2500; d. enlargement of triradiate process at tip of spine, top view, ×4900; e. view of ultimate chamber near base of neck (upper left-hand corner) showing increased radiate pattern of spines, ×500; f. view of portion of initial chamber, showing the anastomosing processes at end of spines, ×500.

2–3. ***Discorbis*? *olutensis*,** new species 82

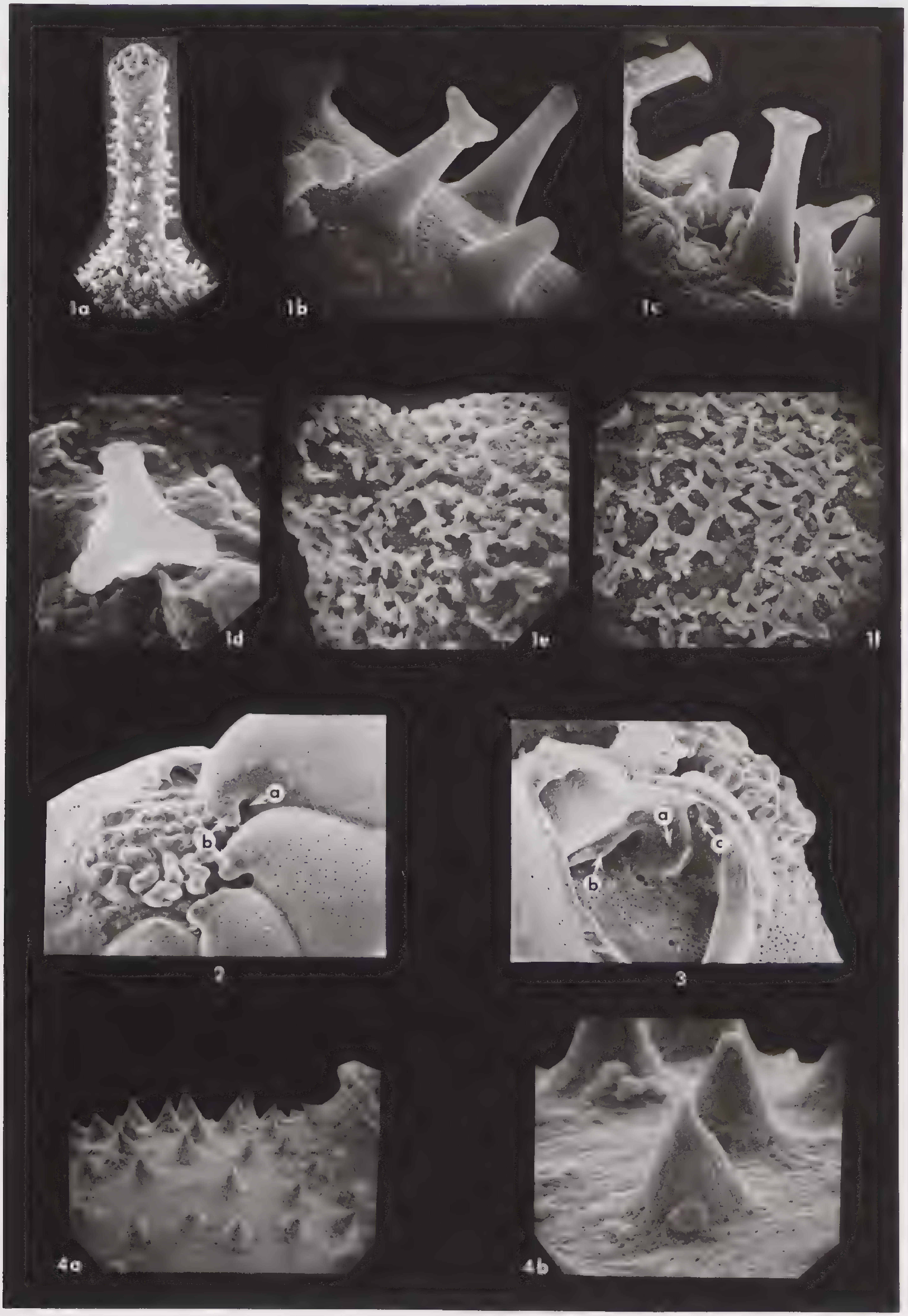
Locality PD-35.

2. Paratype (USNM 400655): enlargement of umbilical area showing pustulose umbilical plug, infolding of chamber wall (a), and supplemental apertural flaps (b), ×288.
3. Paratype (USNM 400656): dissected penultimate chamber showing internal structures: infolding of chamber wall (a), primary aperture of antepenultimate chamber with lip (b) and supplemental aperture (c), which enters the umbilical area under the apertural flaps (fig. 2), ×350.

4. ***Uvigerina hispida*** Schwager 72

Locality PD-68.

a. enlargement of portion of ultimate chamber showing spines; neck is in upper right-hand corner, ×230; b. detail of spines shown in fig. 4a—note conical shape, ×975.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"BIOZONES"
SAMPLE NUMBER
PLANKTIC/BENTHIC RATIO
TOTAL BENTHIC COUNT
"BIOZONES"
CONCEPCION
UPPER
29 .28 369
21 .65 330
63 1.19 567
66 1.35 446
39 .86 707
40 .95 942
LOWER
43 .74 556
54 .96 539
45 .96 791
49 .87 457
ENCANTO
46 .80 615
52 .54 639
4 2.30 1694
56 .62 692
58 .85 468
35 .46 887
72 .33 426
68 .65 497
79 .40 319
77 .39 466

Text-figure 15.—Percent abundance of benthic foraminifers for the early Pliocene "biozones" in the study area. Twenty representative samples were chosen for this chart and they are shown in stratigraphic order. A minimum of 300 benthic specimens were counted in each sample. The total benthic count and the planktic/benthic ratio is shown at the right side of the chart. Two hundred-twelve taxa comprising 108 genera are recognized: 86% calcareous perforate, 10% agglutinated, and 4% porcellaneous.

An (x) is used to represent occurrences that represent less than 1% of the sample. Prefixes from the sample numbers are deleted to save space. The sample localities are shown in the Appendix.

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PREPARATION OF MANUSCRIPTS

Bulletins of American Paleontology usually comprises two or more separate monographs in two volumes each year. This series is a publication outlet for significant longer paleontological monographs for which high quality photographic illustrations and the large quarto format are a requisite.

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Authors must provide three (3) copies of the text and accompanying illustrative material. The text and line-drawings may be reproduced xerographically, but glossy prints at publication scale must be supplied for all half-tone illustrations and photographic plates. These prints should be identified clearly on the back.

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Authors are requested to enclose $10 with each manuscript submitted, to cover costs of postage during the review process.

Collinson, J.
1962. *Size of lettering for text-figures.* Journal of Paleontology, vol. 36, p. 1402.

Gilbert Dennison Harris
(1864 - 1952)

Founder of the *Bulletins of American Paleontology* (1895)

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